

Residual need in orthodontically untreated 16–20-year-olds from areas with different treatment rates

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SUMMARY Knowledge concerning residual orthodontic need among individuals who have passed the age at which orthodontic treatment is normally provided, is important in the discussion of guidelines for the provision of care. The purpose of the present study was to examine and compare orthodontic need (objective and subjective) in cohorts of orthodontically untreated individuals from areas with various treatment rates. A total of 250 individuals, aged 16–20 years, comprised four samples representing cohorts from areas in Norway with low, medium, and high treatment rates. The occlusion was assessed according to a treatment need index (NOTI) from clinical and radiographic records, and dental cast measurements. Attitudes were assessed from questionnaires addressing satisfaction with dental arrangement, desire for treatment, and value placed upon well-aligned teeth.

A significant decrease in occurrence of normative need ($P < 0.001$) and reported dissatisfaction ($P < 0.05$) was observed in samples representing increasing treatment rates. Dissatisfaction was completely eliminated among individuals from the high treatment rate area. Although a significant association between severity of malocclusion and desire for treatment existed within samples, this was not reflected in a corresponding trend for a decrease in desire across the samples. Well-aligned teeth seemed to be taken for granted among individuals from the area with a high treatment rate. From the present observations, a 'correct' level of treatment provision could not be identified.

Introduction

Variation in receipt of orthodontic treatment has been ascribed to both patient factors, such as expectations, familiarity with appliances, general dental behaviour, and norms for acceptable dental appearance, as well as characteristics of the services such as availability and funding (Shaw *et al.*, 1991; Breistein and Burden, 1998). Internationally, a wide diversity in prescription rates has been observed among orthodontists and the establishment of international standards for treatment need through orthodontic indices has been suggested (Richmond and Daniels, 1998).

The intervention rate is a key factor in planning and financing of orthodontic services nationally, and attempts have been made to define a specific treatment rate (Sundhedsministeriet, 1990). In addition to restricting treatment from a resource perspective, a more

theoretical argument has been proposed in favour of rationing orthodontic care. Helm (Helm, 1990) postulated that the threshold of the population's acceptance of aberrations in dento-facial appearance would be lowered when the most pronounced malocclusions were eliminated. Accordingly, the concepts of clinical practice would be affected, which in turn might influence the public's expectations. A gradually increasing intervention rate may therefore result. Recent studies have indicated high expectations to the outcome of orthodontic care among the parent generation in Norway (Birkeland *et al.*, 1996) and the USA (Bennett *et al.*, 1997).

Premises for establishing guidelines for provision of orthodontic care may be derived from professional and/or lay perspectives. Attempts to define need professionally have resulted in a number of orthodontic indices based on health

risks associated with malocclusion. These indices serve to prioritize funding of treatment in some countries. In Norway, a uniform system has been introduced nationally for remuneration of costs applying the NOTI. The decision to initiate treatment is, however, based on a discussion between the patient/parents and the orthodontist on the relative benefits of treatment, in which the index does not play a direct role.

By studying samples of treated individuals the health gain obtained by the treatment may be documented. This approach has certain limitations when used to examine the appropriateness of certain levels of provision, as unmet need among the untreated also is important in the overall evaluation of outcome of care. The purpose of the present study was to examine both objective and subjective treatment need among orthodontically untreated late adolescents/young adults in areas with different treatment rates in an attempt to establish premises for provision of care. The objectives were to compare occurrence of malocclusion, and the subjects' attitudes to

their own dental appearance and orthodontic treatment, and to analyse the relationship between treatment rate, malocclusion, and attitudes.

Subjects

The subjects consisted of individuals aged 16–20 years living in four different areas in Norway, and who were participants in cohort studies on prevalence of malocclusion and attitudes to dental appearance and orthodontic treatment. In the present report, only the untreated individuals were included ($n = 250$). Samples I and II represented areas (populations) with low treatment rates (18 and 23 per cent), sample III was from an area with a treatment rate similar to the national average (medium rate, 34 per cent), and sample IV represented an area with a high treatment rate (63 per cent). The various sample and population characteristics are presented in Table 1. The treatment rates in samples I, II, and IV were calculated as the proportion of treated individuals among the respondents in the

Table 1 Overview of the study of 250 orthodontically untreated individuals from four areas in Norway according to sample and population characteristics.

(a) Sample characteristics.

	Sample I	Sample II	Sample III	Sample IV
Treatment rate in area	Low (18%)	Low (23%)	Medium (34%)	High (63%)
Number of individuals	94	75	50	31
Females	48	50	25	10
Males	46	25	25	21
Age (years)	18	20	18	16
Born, year	1973	1973	1971	1980
Examination year	1991	1993	1989	1996

(b) Population characteristics.

	Urban area south-east	Rural area north	Urban area south-east	Urban area south-east
DMFT ratio *				
12 years	0.97	1.18	0.97	0.95
18 years	0.96	1.06	0.88	0.95
Income ratio *				
12 years	1.03	0.96	1.03	1.00
18 years	1.00	0.98	1.04	1.01

*The figures represent average DMFT and average income in the region relative to the national averages.

invited cohorts. The treatment rate in sample III was based on official reports (Norges offentlige utredninger, 1986) and a previous cohort study (Stenvik *et al.*, 1996a).

The approach for establishing the various samples differed slightly, depending on the size of the parent population (cohort), as well as the necessity to accommodate the routines of municipal dental clinics. Samples I and II were established by inviting all individuals in the particular cohort and area to participate in the study. They were asked in letters to attend a local dental clinic for a clinical examination and an interview (Espeland *et al.*, 1993; Stenvik *et al.*, 1997a,b). Samples III and IV were drawn from larger populations (cohorts), and individuals living in different parts of the investigated areas were selected to obtain a socio-economic spread. Whereas the individuals in sample III were consecutively examined and interviewed during their annual routine dental visits at public health clinics (Espeland and Stenvik, 1991), the subjects comprising sample IV were asked in letters to participate in the study (Fernandes *et al.*, 1999).

Data on average DMFT in the cohorts and average income in the regions were obtained from the dental health authorities and the Norwegian Central Bureau of Statistics in order to provide background information on general dental health status and socio-economic level. The data, which are representative for the years when the individuals were aged 12 and 18 years, are given in Table 1 as a ratio relating the average values for the area to the national average.

Methods

The individuals in all samples were clinically examined and interviewed according to the same procedures. Impressions for dental study casts were obtained from all the individuals.

Assessment of occlusion

From clinical and radiographic records and cast measurements, the subjects were classified according to the NOTI, which is used by the Norwegian Health Insurance Scheme for reimbursement of

treatment costs (Table 2). With this index various morphological traits are allocated to four categories of need (A–D) according to their severity. Categories A, B, and C represent normative need labelled ‘very great need’, ‘great need’, and ‘obvious need’, respectively, whereas category D (‘little/no need’) comprises minor anomalies only. The highest scoring trait present in an individual determines the category. In addition to specifications for clinical application of the index given by the National Health Insurance Scheme (Rikstrygdeverket, 1991), a few additional conventions were defined (Stenvik *et al.*, 1996b). Categorization of individuals was made by two examiners independently and joint re-evaluations were performed in cases of disagreement between examiners. Reliability of categorization was assessed by duplicate measurements of all casts in sample I.

Attitudes to dental appearance and orthodontic treatment

The interviews were performed with the use of questionnaires, which were completed by the respondents before any information concerning their occlusal status or aspects of orthodontic treatment were provided. The wording of three questions relating to satisfaction with own dental arrangement, desire for orthodontic treatment, and the individual’s appreciation of well-aligned teeth for overall facial appearance are shown in Table 3. The questions were accompanied by four fixed alternative answers ranging from a strongly positive to a strongly negative response.

Statistical procedures

Agreement within and between examiners in grouping individuals into NOTI categories was assessed by Kappa statistics. For statistical analysis of differences between the samples the Chi-squared test for trend was applied after dichotomizing the variables (Altman, 1991). The test examines whether variation between ordered groups can be attributed to a trend across the groups. Spearman rank-order correlation coefficients were calculated to examine associations between variables within each sample.

Table 2 The Need for Orthodontic Treatment Index (NOTI) used for social insurance refunding in Norway.*Category A: very great need*

1. Cleft lip–jaw–palate
2. Inherited or acquired craniofacial anomalies
3. Severe anomalies requiring a combination of orthodontics and orthognathic surgery
4. Anomalies of comparable severity

Category B: great need

1. Overjet 9 mm or more
2. Unilateral buccal or lingual crossbite on three or more pairs of opposing teeth with forced bite and/or asymmetry
3. Anterior open bite with occlusal contact on molars only
4. Impacted incisors and canines where appliance therapy is necessary
5. Anterior crossbite on all incisors
6. Anterior teeth missing due to agenesis or tooth loss
7. Increased overbite (deep bite) with labial or palatal impingement of the soft tissue with two or more teeth
8. Bilateral buccal crossbite (scissors bite) on two or more pairs of opposing teeth
9. Agenesis of two or more teeth in the same quadrant (3rd molars excepted)
10. Anomalies of comparable severity

Category C: obvious need

1. Overjet 6–9 mm
2. Open bite on three or more pairs of opposing teeth
3. Inversion of anterior teeth
4. Increased overbite (deep bite) without contact on anterior teeth, or with contact on the gingival ¼ of the palatal surface of the maxillary anterior teeth
5. Agenesis of single teeth in the lateral segments
6. Median diastema of 3 mm or more, or pronounced general spacing of anterior segment
7. Pronounced crowding of anterior teeth
8. Occlusal disorder combined with strong subjective dysfunction symptoms
9. Anomalies of comparable severity

Category D: little/no need

1. Overjet less than 6 mm
2. Bilateral crossbite
3. Anterior and lateral open bites on fewer than three pairs of opposing teeth
4. Increased overbite (deep bite) with occlusal contact incisal to the gingival ¼ of the palatal surface of the upper anterior teeth
5. Local cross- and scissors bite without asymmetry or forced bite
6. Moderate crowding in anterior and lateral segments
7. Median diastema less than 3 mm
8. Moderate spacing in anterior and lateral segments

The genders were pooled, since no differences appeared for any of the variables.

Results

Occlusal status

Results from reliability tests revealed Kappa values of 0.85 and 0.91 for inter- and intra-examiner agreement, respectively. The lower 95 per cent confidence limits were 0.68 and 0.82.

None of the individuals in any sample had malocclusion in the most severe category (A).

A statistically significant difference between the samples was observed, indicating a decrease in the proportion of individuals with normative need (categories B and C) with an increasing population treatment rate ($P < 0.001$; Table 4 and Figure 1).

Attitudes to dental appearance and orthodontic treatment

The distributions of answers to the three questions about attitudes to malocclusion and orthodontic treatment are presented in Table 3

Table 3 Distribution of individuals in samples I–IV according to their answers to questions concerning attitudes to malocclusion and orthodontic treatment. Relative frequencies in parentheses.

	Sample I	Sample II	Sample III	Sample IV
Treatment rate in area	Low (18%)	Low (23%)	Medium (34%)	High (63%)
Number of individuals	94	75	50	31
<i>How satisfied are you with the arrangement of your anterior teeth?</i>				
Very dissatisfied	1 (1)	0 (0)	1 (2)	0 (0)
Dissatisfied	20 (21)	15 (20)	9 (18)	0 (0)
Satisfied	56 (60)	40 (53)	32 (64)	25 (81)
Very satisfied	17 (18)	20 (27)	8 (16)	6 (19)
Chi-square for trend = 5.115, 1 df, $P < 0.05$				
<i>Do you want to have your teeth straightened?</i>				
Yes, definitely	2 (2)	1 (1)	1 (2)	0 (0)
Yes, I think so	13 (14)	21 (28)	6 (12)	4 (13)
No, I do not think so	36 (38)	24 (32)	19 (38)	13 (42)
No, definitely not	43 (46)	29 (39)	24 (48)	14 (45)
Chi-square for trend = 0.289, 1 df, NS				
<i>Do you consider well-aligned teeth important for overall facial appearance?</i>				
Very important	12 (13)	30 (40)	11 (22)	4 (13)
Rather important	65 (69)	39 (52)	34 (68)	20 (64)
Not important	16 (17)	6 (8)	5 (10)	7 (23)
Not important at all	0 (0)	0 (0)	0 (0)	0 (0)
Chi-square for trend = 0.009, 1 df, NS				

Table 4 Distribution of individuals in samples I–IV according to category of treatment need (NOTI). Relative frequencies in parentheses. Categories B and C represent normative need.

	Sample I	Sample II	Sample III	Sample IV
Treatment rate in area	Low (18%)	Low (23%)	Medium (34%)	High (63%)
Number of individuals	94	75	50	31
Great need (B)	2 (2)	3 (3)	0 (0)	0 (0)
Obvious need (C)	35 (37)	24 (32)	13 (26)	5 (16)
Little/no need (D)	57 (61)	48 (64)	37 (74)	26 (84)

Chi-square for trend = 6.739, 1 df, $P < 0.001$.

and Figure 1. A statistically significant difference between the samples, indicating a trend, was observed only for the subjects' reports on level of satisfaction/dissatisfaction with their dental appearance ($P < 0.05$).

Approximately 20 per cent of the individuals in samples I, II, and III (low and medium treatment rate areas) indicated that they were dissatisfied with the arrangement of their anterior teeth, but almost none reported being strongly dissatisfied. In sample IV (high treatment rate area), all the individuals were satisfied with their dental appearance.

A desire for orthodontic treatment was more frequently expressed by the individuals in sample II (29 per cent) compared with the other samples (13–16 per cent). Only one or two individuals in each sample reported a strong desire. In samples II and IV, some individuals desired treatment, although they were satisfied with their teeth, whereas a reverse relationship between the two variables was observed in the two other samples.

The majority of the respondents in all four samples valued well-aligned teeth as important for overall facial appearance (77–90 per cent in

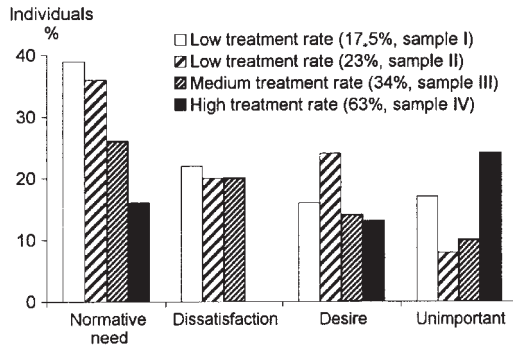


Figure 1 Relative distribution of individuals in samples I–IV with normative need (NOTI categories B and C), who reported dissatisfaction with arrangement of anterior teeth, desire for orthodontic treatment, and valued well-aligned teeth unimportant for overall facial appearance. Samples I and II represent areas with low treatment rate (18 and 23 per cent), sample III medium treatment rate (34 per cent), and sample IV high treatment rate (63 per cent).

various samples). The extreme response ‘very important’ was most frequently chosen by the individuals in sample II (40 per cent). The highest proportion of individuals considering regular teeth not to be important for facial appearance (23 per cent) was observed in the sample from the area with a high level of provision of orthodontic care (sample IV).

Association between variables within samples

In samples I, II, and III both dissatisfaction and desire for treatment were significantly associated with severity of malocclusion as assessed by

NOTI (Table 5). In these samples, a significant association between the respondents’ expressed dissatisfaction with dental appearance and desire for treatment was observed ($P < 0.001$).

Discussion

The presumption was made that malocclusion prevalences in the childhood populations were similar in the areas examined, as data from various epidemiological studies indicate only a limited variation within Norway (Engh, 1970; Forøy, 1979; Olsen, 1986; Mathisen, 1992). A somewhat different sampling procedure in one of the groups (invitation to attend the study during routine annual dental check-up in sample III, and mailed invitations in samples I, II, and IV) resulted in a higher response frequency in that sample as all participated. In the invited samples, non-attendance may have biased the results. One of these samples (IV) had been monitored longitudinally and recordings of malocclusion and concern had been obtained at an earlier age. However, comparisons of baseline data revealed no statistically significant differences either in malocclusion or in concern scores between the drop-outs and the participating subjects (Fernandes *et al.*, 1999). Accordingly, there is no obvious indication that the drop-outs have biased the results.

Estimates on dental health and socio-economic status showed only slight variation between the various regions, but have been included in the characterization of the samples to provide

Table 5 Association between malocclusion assessed by NOTI and attitudes to malocclusion and orthodontic treatment assessed from three questions (see Table 3), and between the answers to each of the three questions. Spearman rank-order correlation coefficients.

Variables	Sample I	Sample II	Sample III	Sample IV
NOTI versus dissatisfaction	0.25*	0.35**	0.43**	0.22
NOTI versus desire	0.27**	0.39**	0.39**	0.02
NOTI versus importance	0.02	-0.14	-0.05	0.23
Dissatisfaction versus desire	0.66***	0.58***	0.55***	0.11
Dissatisfaction versus importance	0.16	-0.14	-0.03	0.07
Desire versus importance	0.06	-0.18	0.08	0.32

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

background information. These factors may, to some extent, influence receipt of orthodontic treatment (Searcy and Chisick, 1994; Bennett *et al.*, 1997; Breistein and Burden, 1998). As it was not an objective of the present study to analyse causes for the differences in treatment rates, these data were not included in any statistical analyses. Many variables are involved in establishing intervention rates. Recently, Richmond and Daniels (1998) related the effect of different systems for organization and funding of care internationally (practitioner factors) to professional assessment of treatment need under standardized and artificial conditions. The authors stated that it is likely that the perceptions of the patient would be significantly different from those of the specialty.

The main purpose of the present study was to analyse the effect of varying treatment rates within a generally uniform system for the delivery of orthodontic care (screening and referral by the public dental health scheme to orthodontic specialists working in private practice; remuneration of treatment costs from national insurance to the patient). This would eliminate the potentially varying influence of practitioner factors examined by Richmond and Daniels (1998). The close association observed between increasing treatment rates and a decrease in residual malocclusion among the untreated individuals confirms the similarity in prevalence of malocclusion among the populations. In all samples, it appeared that the care system had succeeded in identifying and treating those individuals with the most severe malocclusions. This may explain why only six of the total number of 500 responses (1 per cent) to the questions about dissatisfaction and desire for treatment were at the extreme negative end of the scale indicating urgent need.

No obvious trends based on the increasing treatment rates appeared across the samples on desire for treatment and appreciation of well-aligned teeth (Table 3). It should be observed, however, that the ratio of respondents ascribing dental appearance being without importance for overall facial appearance was three times greater among individuals in the high treatment rate sample IV compared with a low-rate sample II

(23 versus 8 per cent). A similar finding was reported by Tulloch *et al.* (1984). In a study comparing two populations, teeth were valued significantly less important in the area with a high specialist to population ratio. This may be interpreted to imply that well-aligned teeth may be taken for granted among populations exposed to high treatment rates.

An association was observed between increasing treatment rates and reduced dissatisfaction with dental arrangement. This trend was not linear, but was mainly due to the complete elimination of dissatisfaction among subjects in the high rate area. Apparently, the ratio of dissatisfied individuals in the untreated population may be negligible by high provision rates. On the other hand, a high treatment ratio raises the issue of cost-benefit, as the potential health gain to be obtained by treating borderline malocclusions may be small.

Within each of the samples I, II, and III (Table 5) an association was observed between malocclusion, dissatisfaction, and desire for treatment, which is in agreement with previous observations that malocclusion is an important predictor for uptake of orthodontic treatment (Albino *et al.*, 1981). The lack of statistical significance for sample IV may probably be ascribed to the skewed distributions, as almost all subjects were without malocclusion and were satisfied. The significant association between malocclusion and desire for treatment within each of the samples was, interestingly, not reflected in a corresponding tendency across samples between treatment rates and desire for treatment as expressed by the chi-squared test for trend. Accordingly, this finding may be interpreted to imply that Helm's claim that the public's acceptance of irregularities decreases when treatment rates increase (Helm, 1990) has not been disproved by the present data. Most likely, the factors involved continuously interact, and do not lend themselves to clear-cut cause-and-effect analysis. Initially, the treatment rate may be considered as the independent variable affecting attitudes, which would at that stage become the dependent variable. According to the postulate, attitudes subsequently become the independent variable affecting the treatment rate.

A 'correct' level of treatment provision could not be identified on the basis of the present observations. Treatment demand apparently results from a multitude of both client- and provider-related factors (Shaw *et al.*, 1991), some of which represent general societal norms. Decisions about treatment should therefore be made on an individual basis, in which a structured formal informed consent process is of major importance. Orthodontic treatment need indices may within this context serve as useful 'tools' (Nash, 1988) to educate and inform the potential patient, as well as allocating third party payment.

Conclusions

A significant relationship was observed between increasing treatment rates and a decrease in residual malocclusion. Irrespective of treatment rates an association was observed between presence of malocclusion, dissatisfaction, and desire for treatment within the samples. Increasing treatment rates did not, however, reduce the desire for treatment across the samples. Well-aligned teeth seemed to be taken for granted more frequently among individuals from the area with a high treatment rate. These findings should be taken into account both when orthodontic services are planned and in the process of making individual decisions about treatment.

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