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A longitudinal study on subjective and objective orthodontic treatment need

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SUMMARY The purpose of the study was to analyse changes in professionally-defined need and self-perceived need between the ages of 12–20 years. In 1985, occlusion and perceived need for treatment were recorded in 306 12-year-olds (born 1973) living in five communes in Finnmark, the most northern part of Norway. In 1993–94, 271 of the individuals were traced through the Norwegian Central Person Register and invited in letters to attend a clinical examination and an interview. A total of 80 individuals responded, with a mean age of 20.7 years. Professionally-defined need was assessed according to the Need for Orthodontic Treatment Index (NOTI) which is used by the Norwegian Health Insurance System for reimbursement of treatment costs. Change in category of need between 12–20 years was used as a measurement of health gain. Perceived need was measured by the individuals' responses to a question about desire for treatment.

Individuals who received treatment ($n=22$) showed an improvement in occlusion (health gain) corresponding on average to one category of need. The occlusal status of the untreated individuals was unchanged. All the individuals that desired treatment at 12 years of age ($n=15$) did not want treatment at 20, and they were satisfied with their dental arrangement. Most of these individuals had received treatment, but a few with minor malocclusions had at age 12 been informed about the small objective need and refrained from treatment. All the individuals that wanted treatment at 20 years of age, 29 per cent of the total sample, had not desired treatment at 12 years of age. The results underline the importance of information and education during orthodontic counselling of potential patients.

Introduction

Knowledge about prevalence of malocclusion and treatment need in a population is essential for the planning of orthodontic services. Evaluation of the outcome of the service includes information about the short- and long-term results of treatment. As the ultimate goal of a health service is to meet the public's needs, evaluation of outcome should apply not only to the individuals who receive care, but also to those who are left untreated. Furthermore, to analyse whether treatment decisions and treatment outcome are meaningful to the public at large, professional measurements should be supplemented by and related to measurements of individuals' self-perception of occlusion and need for treatment.

Some cross-sectional epidemiological studies on treatment need which also have included individuals' self-perception of occlusion, have been conducted on unselected adolescent and adult populations (Mohlin, 1982; Gravely, 1990; Burgerdijk *et al.*, 1991; Pancherz and Hahn, 1992; Salonen *et al.*, 1992). In a randomly-selected adult Swedish population 20 per cent of individuals in the age group 20–29 years (treatment frequency 28 per cent), were assessed to be in need of treatment (Salonen *et al.*, 1992), and 11 per cent reported that they desired treatment. A Dutch study (Burgersdijk *et al.*, 1991) found that about 40 per cent of both previously treated and untreated young adults (15–34 years) had occlusal anomalies assessed to require treatment. Furthermore, 28 per cent of the treated and 22 per cent of the untreated reported that they were dissatisfied with the orthodontic condition of their anterior teeth.

One attempt has previously been made to study malocclusion and perceived need longitudinally (Helm *et al.*, 1983, 1985). Malocclusion was recorded at 15 years of age (in 1965/1966),

and the follow-up, 15 years later, was based on mailed questionnaires. Although not strictly longitudinal, these studies have provided valuable information about the relationship between malocclusion and individuals' orthodontic perceptions. Studies which have evaluated orthodontic treatment results by including patients' opinions have reported variable proportions (1–30 per cent) of patients being dissatisfied with the result (Myrberg and Thilander, 1973; Berg, 1979; Gravely, 1989; Espeland and Stenvik, 1991; Pancherz and Hahn, 1992; Espeland *et al.*, 1993). These cross-sectional studies do not include information about the occlusal condition and the individuals' attitudes (perceived need) at the time when treatment decisions were made. For previously treated individuals, outcome of treatment and satisfaction with the result should preferably be related to the pre-treatment condition and the improvement obtained.

In the present study an unselected sample of individuals from Finnmark, Norway was examined in childhood, at 12 years of age, and 8–9 years later. The purpose of the study was to analyse changes in professionally-defined need and self-perceived need between the age of 12 and about 20 years, both among the individuals who had received treatment and among the untreated. The relationship between changes in professionally-defined need and self-perceived need was examined, and related to whether orthodontic treatment had been carried out or not.

Subjects and methods

Subjects

In 1985, malocclusion and need for orthodontic treatment were recorded in 12-year-old children living in eight communes in Finnmark, Norway (Mathisen, 1992). The sample included all the children born in 1973 who attended the public dental health service. Because these children were thoroughly examined orthodontically, as well as interviewed about treatment need, the recordings gave an opportunity to study changes in need longitudinally. The individuals living in the five largest of the eight communes were selected for a follow-up study. In 1985, 306 children from these five communes had been examined.

In 1993–94, with assistance from the Norwegian Central Person Register, 271 of the 306 individuals who had been examined at 12 years of age, were traced as being members of the households in these five communes. They were invited in letters to reattend a clinical examination and a dental health interview at a local dental clinic (approval no. S-93120, Norwegian Ethical Committee for Medical Research). A total of 80 individuals (55 females, 25 males) responded. Due to military service or education only 181 of the 271 that were traced were still living at their home address at the time of investigation. Attendance rate was therefore 30 per cent among those traced, and 44 per cent among those that had not temporarily moved. The mean age of the individuals examined in 1993–94 was 20.7 years.

Professionally-defined need

At 12 years, occlusal relationships were described by recording of 17 separate malocclusion traits according to criteria adapted from Björk *et al.* (1964) (see Mathisen, 1992). All recordings were made by the same examiner (AM); nine continuous variables were measured to the nearest millimetre, and eight discrete variables were recorded as present or absent.

At 20 years, impressions for study casts were obtained from all individuals, and they were assigned to a category of treatment need according to the Need for Orthodontic Treatment Index (NOTI, Table 1) on the basis of clinical examination and cast measurements by two of the authors (LE and AS). This index is used by the National Health Insurance System for reimbursement of treatment costs, and defined morphological traits have been allocated to four categories of need according to their severity. The categories A–D have been labelled 'very great need' (cleft lip and palate, and severe skeletal anomalies only), 'great need', 'obvious need', and 'little/no need'. The most severe trait present in an individual determines the category of need. None of the participants were in the most severe category A, at 12 or 20 years.

As the applied index for orthodontic need was introduced in 1990 and hence, not available for the examination at 12 years, the data from the recordings at 12 were applied for determining NOTI category at that age. Generally the most severe trait at 12 could be identified from the comprehensive registration of the single

Table 1 The Need for Orthodontic Treatment Index (NOTI). The various dentofacial conditions and morphological traits allocated to each of the four categories.

Group 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

Group 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 contacts 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 agenesia 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

Group 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 1/4 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

Group D: little/no need
1 Overjet less than 6 mm
2 Bilateral crossbite
3 Anterior and lateral open bite on fewer than three pairs of opposing teeth
4 Increased overbite (deep bite) with occlusal contact incisal to the gingival 1/4 of the palatal surface of the maxillary 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

traits even if study models were not collected at 12 years. Conventions were made for two traits. 'Impacted incisors and canines where appliance therapy is necessary' (trait 4 in category B) were only applied if the diagnosis at 12 years were impacted incisor or canine, and that the individual had received orthodontic treatment. The other convention was for deep bite (trait 4 in category C): increased overbite was recorded if more than 5 mm.

When the conversion from recorded single traits to NOTI category was repeated after four months, only one individual was allocated to a different category. The reliability of allocating individuals according to NOTI categories has been tested previously. Agreement between examiners on the category was 0.87 and intra-examiner agreement was 0.91 expressed by the Kappa statistics (Espeland *et al.*, 1992). Both values were interpreted to represent almost perfect agreement beyond chance.

Health gain

For each subject the category of need at 12 and 20 years was compared. Change in category was applied as a measurement for health gain. The calculation of health gain scores can be seen from Table 2. For example, a score of 2, the maximum that could be obtained, was assigned when an individual in category B (great need) at 12 years was in category D (little/no need) at 20 years.

Table 2 Change in category of treatment need (NOTI)* between 12–20 years, and corresponding health gain scores among 22 orthodontically treated and 58 untreated individuals.

Change in need category	Health gain score	Number of individuals with the score	
		Treated ($n=22$)	Untreated ($n=58$)
B→D	2	7	0
B→C	1	1	0
C→D	1	8	11
B→B	0	0	1
C→C	0	4	16
D→D	0	2	26
D→C	−1	0	4
Mean health gain score (maximum mean score possible)		1.0 (1.3)	0.1

* NOTI category: B = great need, C = obvious need, D = little/no need.

Self-perceived need

The individual's response to a question about desire for orthodontic treatment was used as a measurement for perceived need.

In 1985, the children and one of their accompanying parents were interviewed separately by one examiner, and asked whether they desired orthodontic treatment or not. The answers were grouped as 'desire treatment', 'do not desire treatment', and 'don't know'. The association between child and parental response to the question about desire for own/child's treatment at 12 years was significant (Spearman rank-order correlation coefficient 0.80, $P<0.001$). Disagreement in response existed for only seven family units. For six of these family units the child did not want treatment, whereas the parent answered 'don't know'. Only the child's response was used in the analysis.

At the follow-up the individuals were interviewed with the use of questionnaires with fixed alternative answers. One observer, unknown to the respondents, was present to give guidance if necessary. Desire for treatment, or perceived need, was assessed by the question: "*Do you want to have your teeth straightened?*" (yes, very much/yes, probably/no, probably not/no, not at all). Satisfaction with dental arrangement was measured on a similar scale (very satisfied/satisfied/dissatisfied/very dissatisfied) as a response to the question: "*How satisfied are you with the arrangement of your anterior teeth?*"

The desire variable was dichotomized into a positive (desire) and a negative (no desire) response. An indifferent response among the children was considered not to represent a perceived need and was therefore grouped as a negative response. A change from a positive to a negative response during the period 12–20 years was assigned the score 1, a change from a negative to a positive response the score −1, and a persistent positive or negative response was assigned the score 0.

Statistical analysis

Differences between groups were analysed by the Chi-square test. Association between variables were analysed by the Chi-square test and Spearman rank-order correlation coefficient.

Results

No differences between genders existed for any of the variables, and the results are therefore presented as a pooled analysis. Of the 80 individuals, 22 (13 females, nine males) had received orthodontic treatment.

Professionally-defined need and health gain

Cross-sectional comparisons of the distribution of treatment need categories at 12 and 20 years revealed a significant difference among the treated subjects (Chi-square = 20.842, 2 df, $P<0.001$), but not among the untreated (Chi-square = 1.731, 2 df, NS). Longitudinal comparisons of distribution of need categories are given in Table 3a (treated) and Table 3b (untreated). The figures along the diagonal line indicate the number of subjects that showed no change in category during the period (six treated, 43 untreated). Above the diagonal are subjects with an improvement in occlusion (16 treated, 11 untreated), whereas the figures below the

Table 3a Relationship between number of individuals in various treatment need categories (NOTI, Table 1) at 12–20 years among 22 orthodontically treated individuals.

	Number in categories at 20 years		
	Great (B) ($n=0$)	Obvious (C) ($n=5$)	Little/no (D) ($n=17$)
Number in categories at 12 years			
Great (B) ($n=8$)	0	1	7
Obvious (C) ($n=12$)	0	4	8
Little/no (D) ($n=2$)	0	0	2

Table 3b Relationship between number of individuals in various treatment need categories (NOTI, Table 1) at 12 and 20 years among 58 orthodontically untreated individuals.

	Number in categories at 20 years		
	Great (B) ($n=1$)	Obvious (C) ($n=20$)	Little/no (D) ($n=37$)
Number in categories at 12 years			
Great (B) ($n=1$)	1	0	0
Obvious (C) ($n=27$)	0	16	11
Little/no (D) ($n=30$)	0	4	26

diagonal refer to number of subjects whose occlusion became worse (none in the treated and four in the untreated group).

In Table 2 the health gain scores are given. The mean health gain score was 1.0 for the treated and 0.1 for the untreated individuals. The maximum mean health gain score possible to obtain for the treated individuals was 1.3, that is, if all the 22 individuals were in category D (little/no need) at 20 years of age.

Self-perceived need

A desire for treatment was reported by 15 individuals at the age of 12 years and by 23 at the age of 20 years. A significant association existed between expressed desire and category of treatment need at both 12 years ($P<0.01$) and 20 years ($P<0.001$) (Table 4).

Among the 15 individuals who expressed a desire in childhood, none wanted treatment as young adults (Table 5). They also responded positively to the question about satisfaction. Of the 65 individuals who did not desire treatment at 12 years, 23 changed their opinion and wanted their teeth corrected in adulthood.

Relationship between changes in professionally-defined need and self-perceived need

The individuals who changed their response to the question about desire for treatment were examined more closely for change in category of need and health gain (Table 5). Of the 15 individuals who desired treatment in childhood and did not express a desire at 20 years, 13 had received treatment. The treatment need categories at 12 and 20 years can be seen from Table 5. The mean health gain score for the 13 treated individuals was 1.1 (maximum mean score possible = 1.4). For the two untreated individuals there was no change in treatment need category.

Of the 23 individuals who did not desire treatment as children, but wanted their teeth straightened as young adults (Table 6), five had received treatment. The mean health gain score for the five treated individuals was 1.2 (max-

Table 4 Distribution of answers to the question about desire for treatment according to treatment need category (NOTI) among 80 individuals at the age of 12 years and 20 years.

Need category	Desire	No desire/ don't know
12 years	$n=15$	$n=65$
Great (B) ($n=9$)	5	4
Obvious (C) ($n=39$)	9	30
Little/no (D) ($n=32$)	1	31
Chi-square = 13.610,2 df, $P<0.01$		
20 years	$n=23$	$n=57$
Great (B) ($n=1$)	0	1
Obvious (C) ($n=25$)	14	11
Little/no (D) ($n=54$)	9	45
Chi-square = 11.843,1 df, $P<0.001$ (B and C collapsed)		

Table 5 Distribution of individuals who changed their response to the question about desire for orthodontic treatment from 12–20 years according to change in category of treatment need (NOTI)* and corresponding health gain scores among 22 orthodontically treated and 58 untreated individuals.

Change in need category	Health gain score	12 years: desire, 20 years: no desire		12 years: no desire 20 years: desire	
		Treated ($n=13$)	Untreated ($n=2$)	Treated ($n=5$)	Untreated ($n=18$)
B→D	2	4	0	2	0
B→C	1	1	0	0	0
C→D	1	5	0	2	2
C→C	0	3	1	0	11
D→D	0	0	1	1	2
D→C	−1		0	0	3
Mean health gain score (maximum mean score possible)		1.1 (1.4)	0	1.2 (1.4)	−0.1

* NOTI category: B = great need, C = obvious need, D = little/no need.

Table 6 Relationship between response to the question about desire for treatment at 12 and 20 years among 80 individuals.

Response at 12 years		Response at 20 years: Desire ($n=23$)	Response at 20 years: No desire ($n=57$)
Desire	$n=15$	0	15
No desire/don't know	$n=65$	23	42

imum mean score possible = 1.4). Among the untreated subjects there were on average only small changes in occlusion and the mean health gain score was −0.1. The associations between change in desire, health gain, and orthodontic treatment were moderate (Spearman rank-order correlation coefficients 0.33–0.55) (Table 7).

Discussion

Subjects and methods

The main reasons for not attending the follow-up examination were the high frequency of 20-year-olds temporarily living outside the community and the long travelling distances in this part of the country. However, it cannot be ruled out that the dentally least concerned individuals were over-represented among the non-respondents, and this may have biased the results towards an overestimation of perceived need among the 20-year-olds.

Because of the limited sample, general conclusions cannot be drawn. The present model to analyse the outcome of the orthodontic service may, however, be applied to samples in other regions. The model is based on the following elements:

1. The same individuals are examined and interviewed on two occasions: (i) in childhood, just before the age when orthodontic treatment usually is initiated, and (ii) in early adulthood, about 5 years after end of active treatment.
2. Both orthodontically treated and untreated subjects are included to examine how the service meets the needs of the public in general.
3. Changes in occlusion are measured by using graded morphological categories which are based on the health rationale for orthodontic intervention, and authorized by the

Table 7 Association between change in desire, health gain (see Table 2) and orthodontic treatment.

Variables	Spearman rank-order correlation coefficient
Change in desire and health gain	0.33
Change in desire and orthodontic treatment	0.40
Health gain and orthodontic treatment	0.55

purchaser (Norwegian Health Insurance System). The relevance of applying these categories is based on the fact that elimination of the morphological characteristics included in the categories is a predominant goal in orthodontics.

4. Information on the patient's attitudes and perceived need for treatment is included to examine if the decisions made in childhood are meaningful, and if the total outcome of the orthodontic service long-term is acceptable to those the care system is supposed to satisfy.

In longitudinal studies which include analysis of attitudes to orthodontics, time-related changes in other variables may operate in addition to age-related changes in dental concern and perceived need. Hence, changing sociocultural norms for acceptable dental appearance as well as access to treatment are factors that have to be considered when the longitudinal results on perceived need are interpreted. This may in part explain the finding that desire for treatment increased from childhood to early adulthood, as a marked improvement in general dental health and an increase in orthodontic manpower have taken place in this part of Norway during the last two decades.

Health gain measured by change in category of treatment need represents a rather rough and approximate estimate for occlusal changes since only the most severe trait present determines the category. Scores are also relative since the maximum score it is possible to obtain depends on the pretreatment severity. In addition, calculation of average scores involves an approximation. Category of need is a discrete variable measured on an ordinal scale and the distance between scores does not necessarily represent an equal amount of health gain.

However, the advantages and the relevance of the measurement may balance these inherent limitations in certain situations. In addition to being relevant and based on a routinely used and authorized index for treatment need, the measurement is easy and quick to apply and therefore suitable for assessment of population groups. This health gain measurement may also have a potential for application in quality assurance for the same reasons. For in-depth analysis of treatment changes, other tools such as the PAR index (Richmond *et al.*, 1992, 1993) would be appropriate.

Results

The proportion of individuals desiring treatment was higher among the young adults (29 per cent) than among the children (19 per cent). Since 28 per cent of the individuals had received treatment, assessment of the service based on these cross-sectional figures only, could easily be interpreted to indicate that the service does not adequately meet the public's needs. Similar observations have also appeared in previous cross-sectional studies (Burgersdijk *et al.*, 1991; Pancherz and Hahn, 1992; Salonen *et al.*, 1992). Longitudinal data, which so far has not been available, brings an opportunity for in-depth analysis of outcome of services.

The longitudinal data revealed a far more complex pattern of associations compared with the cross-sectional data. An increased concern for dental appearance and orthodontic treatment with age became apparent, rather than inadequate decisions and provision of care during childhood and adolescence. Among those who wanted treatment in childhood, none expressed a desire in early adulthood. These individuals included 13 who had received treatment and two who were left untreated. For the treated subjects, acceptable results may in part explain the change in attitude. It cannot be ruled out that cognitive dissonance also may operate.

Furthermore, none of the 23 young adults who perceived a need, had desired treatment in childhood. Five had received treatment with successful outcomes, but wanted further improvement. From the answers to additional questions about treatment experience and satisfaction with results, all five stated that they considered the treatment worth while. In two of the subjects, a small relapse of irregularities in the upper anterior region was the reason for the desire for treatment.

Among the 18 untreated individuals who changed their opinion and wanted treatment as adults, only three showed a worsening of the occlusion. The longitudinal data therefore indicated that increased concern about dental appearance rather than change in occlusion accounted for the increased number of individuals with perceived need for treatment. This is in accordance with other studies (Shaw *et al.*, 1975; Gosney, 1986; Espeland, 1993), and may not be surprising since attitudes to treatment in childhood often reflect the influence of the

family social unit (Lewit and Virolainen, 1968; Albino and Tedesco, 1988).

The present observations of changing attitudes during adolescence have implications for orthodontic counselling, education of patients, and advice, and underline the importance of informed consent and quality assurance of information in orthodontics. Programmes for orthodontic screening, referral, information, and follow-up may to some extent meet the challenges implicit in these findings. Professional knowledge about orthodontic perceptions in different age groups may also be useful.

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