Selection of Dentofacial Measurements for an Orthodontic Treatment Priority Index

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Throughout most of the world, the need for orthodontic treatment far exceeds the available supply. As noted by Kreshover,[1] in the United States alone, "Approximately one-third of the school age population suffers from malocclusions severe enough to require orthodontic treatment. Thus, in 1968, some fourteen million American children could have benefited from such care. However, the four thousand orthodontists in practice that year could treat less than 10% of this group." It is therefore of considerable interest to develop objective criteria for the assessment of the "need for orthodontic treatment" which might aid in the selection of patients to be treated and in estimating the prevalence of malocclusion in this, and other, populations. While such an orthodontic treatment priority index (TPI) clearly depends on a variety of factors, the first step in its construction would logically seem to involve the selection of several dentofacial measurements which could be used to characterize the dentofacial morphology of potential patients in the context of their "need for treatment." A number of investigations, primarily within the American and Scandinavian populations, have provided valuable information in this direction.[2-12] In particular, these studies have verified the earlier, more subjective estimates of the prevalence of malocclusion in these populations.

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The disparity between supply and demand in The Netherlands is similarly acute and it has recently been estimated that the percentage of Dutch children requiring orthodontic treatment is even greater than that observed in the United States.[13] The purpose of the present paper, then, is to take the first step in the construction of an orthodontic TPI for Dutch children. The statistical techniques of stepwise multiple regression[4] and discriminant function analysis[14] are used to study a set of dentofacial measurements to determine which of these measurements are most related to the clinician's assessment of the need for orthodontic treatment and which of these measurements best discriminate the children who *do* require orthodontic treatment from those who *do not*.

Methods and Materials

Relevant data, including demographic information, photographs, dental casts and cephalograms, were collected on a total of 157 children as part of the mixed longitudinal, interdisciplinary study of the growth and development of Dutch children currently in progress at the University of Nymegen.[15] This sample is comprised of 67 boys and 90 girls whose average age, at the time these data were collected, was 10.6 years. For each child, an ordinal measure of his (her) "need for orthodontic treatment" was estimated by two experienced orthodontists according to the scale shown in Table I.

These determinations were made independently by the two orthodontists for each child and the child received the average of the scores assigned by

TABLE I

Definition of the Ordinal Scale Used to Rank Children According to Their "Need for Orthodontic Treatment"

Clinician's Assessment	*Score*
No treatment necessary	10
Need for treatment doubtful	20
Treatment advisable	30
Treatment necessary	40
Treatment mandatory	50

each orthodontist as a measure of his (her) need for orthodontic treatment. In addition, some thirty dentofacial measurements, including those found to be useful in other studies of this nature,[4,16] were measured on each child. The problem considered is that of relating the "need for treatment" (Table I) to this battery of dentofacial measurements by multiple regression analysis and to distinguish between those requiring orthodontic treatment and those not, on the basis of these measurements, by discriminant function analysis. All statistical analyses were performed using MIDAS (Michigan Interactive Data Analysis System) developed at the Statistical Research Laboratory of the University of Michigan.

Results

Table II gives the mean values of several of the dentofacial measurements which, by inspection, appeared to exhibit the most significant trends within each of the groups defined by their "need for orthodontic treatment." Here overjet and overbite, measured from dental casts, refer to measurements made between the left central incisors as described by Moyers.[17] These mean values provide a profile of dentofacial morphology, changes in which are accompanied by changes in the "need for treatment" index and, not incidently, the corresponding sample sizes provide estimates of the proportions of children in each of the priority groups.

While definite differences in the mean values for these measurements according to the "need for orthodontic treatment" are evident by inspection, it seems clear that the need for treatment is a multivariate concept,[14] depending on the *combinations* of values these measurements assume, and that some more-inclusive analysis, such as multiple regression, is required if we are to adequately characterize the relationship between the need for treatment and *all* the dentofacial measurements taken on these children. Some care needs to be taken when utilizing this approach, however.[4] An inspection of the scatterplots between the need for treatment and the other variables considered indicated that, in several cases,

TABLE II

Mean Values for Six Dentofacial Measurements Within Each of the Groups Defined by Their "Need for Orthodontic Treatment," Computed as Averages of the Scores Assigned by Two Orthodontists (Table I)

	Need for Treatment							
	10	15	20	25	30	35	40	45
Measurement	(N=36)	(N=26)	(N=16)	(N=14)	(N=9)	(N=9)	(N=39)	(N=8)
Overjet	1.34	1.39	1.45	1.48	1.46	1.54	1.54	1.84
Overbite	1.24	1.28	1.29	1.30	1.32	1.33	1.33	1.34
Upper Molar Arch Width	46.64	45.24	46.12	45.01	44.39	44.13	44.19	44.12
Art-Gon-Men Angle	131.18	130.02	130.70	130.52	130.21	130.98	129.77	126.97
Lower Arch Length	243.61	241.15	239.33	236.43	230.56	238.33	235.90	230.63
ANB Angle	3.85	4.21	4.99	4.26	4.68	5.23	5.52	6.35

the relationship was more adequately described by a quadratic function than a linear one (corresponding to the fact that treatment is indicated for both high and low values of these measurements). Consequently, in the multiple regression equation with the need for treatment as the dependent variable, the squares of certain dentofacial measurements were included as independent (predictor) variables. The resulting regression equation was significant ($P < 0.0001$) and the multiple correlation coefficient was $R = 0.85$ indicating a close relationship between our battery of dentofacial measurements and the need for treatment index. When a stepwise regression analysis was used, including only those measurements significant at the 5% level of significance, the four most important predictor variables were, in order of importance, overjet, overbite, upper molar arch width, and the angle defined by articulare-gonion-menton. The other variables listed in Table II, while clearly related to the TPI, added no *new* (by virtue of the correlations between the variables) significant predictive information and were consequently excluded from the multiple regression equation.

When the sample was dichotomized into those needing and those not needing orthodontic treatment by including in the former group all those children with a "need for treatment" score of 25 or greater, a *quadratic* discriminant function analysis[14,18] produced the classification matrix shown in Table III. It is seen that of the 70 children not requiring treatment, 58 (82.9%) were correctly classified on the basis of dentofacial measurements; and 12 (17.1%) were misclassified. Of the 70 children requiring treatment, all were correctly classified by the quadratic discriminant function analysis. It should be noted that only 140 of the total of 157 children were included in both the regression and discriminant function analyses due to the absence of data for several of the measurements considered. For multivariate procedures, MIDAS processes only those individuals with no missing data. The mean values shown in Table II, however, were computed using all 157 of the children in the sample.

TABLE III

Classification Matrix for the Quadratic Discriminant Function Analysis Between Those Requiring and Not Requiring Orthodontic Treatment

	Treatment not required	*Treatment required*	*Totals*
Treatment not required	58 (82.9%)	12 (17.1%)	70
Treatment required	0 (0%)	70 (100%)	70

Summary and Conclusions

A battery of thirty dentofacial measurements was studied in an attempt to identify those measurements most closely related to a clinical assessment of the need for orthodontic treatment in the Dutch population. This was done by inspecting the mean values of these measurements computed within several treatment priority groups, a stepwise regression analysis relating treatment priority scores to these dentofacial measurements, and a quadratic discriminant function analysis between the group of children requiring orthodontic treatment and the group for which treatment was deemed unnecessary. The variables identified by inspection were 1) overjet, 2) overbite, 3) upper molar arch width, 4) the angle defined by articulare-gonion-menton, 5) lower arch length and 6) the ANB angle; the first four of these proved to be the most important when the contributions of all thirty of the variables to the TPI were assessed by means of the stepwise regression analysis.

Overjet was also found to be an im-

portant predictor variable by Freer[4,5] in relating Grainger's orthodontic TPI[6] to dentofacial measurements in a group of patients with distoclusion; the ANB angle was found to be the most effective discriminator between normal and Class II American children.[16] The results of the present study then, to this extent at least, agree with those found in other populations. It would appear that any "universal" TPI would have to involve those aspects of dentofacial morphology measured by overjet and the ANB angle.

Within the context of the Dutch population the variables identified proved to be effective discriminators in the decision of "to treat or not to treat," correctly classifying 100% of the children in the sample who were judged by two experienced orthodontists as requiring treatment. While this decision rule did suggest treatment for 17% of the children judged to not require treatment, these cases were in the "doubtful" category (Table I) and might therefore warrant continued monitoring before any final decision is reached.

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