Study seeks to determine value of using the index of handicapping labio-lingual deviations to identify children with handicapping malocclusions

An Evaluation of the HLD Index as a Decision-Making Tool

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THE INDEX of handicapping labio-lingual deviations (HLD index) was proposed as a device to screen applicants for treatment in public health orthodontic programs. This index is designed to assist the public health administrator "to demonstrate the presence or absence of a handicapping [occlusal] condition, and perhaps to measure its severity" (*1*). Thus, the HLD index is primarily intended to identify persons who have a particular condition, rather than to yield a measure of the prevalence of malocculsion in large groups.

Component measurements included in the HLD index are easily obtained and between-examiner reproducibility is within tolerable limits (*1*, *2*). However, the utility of this index as a decision-making tool has yet to be critically evaluated.

One logical method of evaluating its utility (which follows from the purpose of the index) would be to determine what proportion of persons with and without "handicapping" malocclusions can be correctly classified on the basis of their HLD scores. Because satisfactory methods of identifying, or even of defining, a "handicapping" malocclusion are not yet available, such an inquiry would be fruitless, and some other approach is necessary.

Lacking objective criteria, the dental program administrator must rely on professional clinical opinion, his own or a consultant's, to determine which applicants for treatment present a "handicapping" condition. Because HLD index measurements can be made readily by clerical personnel, considerable savings in professional time might therefore be realized by the use of index scores alone. This suggests that an alternative, if less satisfactory, method of evaluation is to ask how well decisions made on the basis of the HLD index scores compare with those made entirely on the basis of clinical judgment, without demanding proof of the correctness or objectivity of that judgment. The study reported here was undertaken to answer this question.

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Materials and Methods

During a survey of the prevalence of Angle's classes of malocclusion in New York State (*3*), dental casts were obtained for a stratified (urban and rural) random sample of 1,413 children, predominantly 15 through 18 years of age. The casts were examined independently by two board-qualified orthodontists who are thoroughly familiar with the usual admission criteria applied in the New York State dental rehabilitation program. This program provides financial assistance when necessary for orthodontic treatment for those children believed to have a "handicapping" malocclusion. The orthodontists were asked to judge whether each child presented a malocclusion severe enough to qualify him for this treatment program and, if so, to classify him as approved. No information about a child other than his dental casts, age, and sex was available to the examiners. Disagreements in classification were resolved by joint reexamination of the casts in question. Separate and independent HLD index measurements were then made on each set of casts, according to the method detailed by Draker (*1*), by a staff member of the bureau of dental health.

Essentially, the HLD index is a summation of five component measurements of deviations from an ideal occlusal norm. These components are overjet, overbite, open bite, mandibular protrusion, and labio-lingual spread (rotation or displacement of individual teeth from an imaginary ideal arch form). All measurements are recorded in millimeters. Only the anterior arch segments are considered. The index includes two additional components, cleft lip or palate and severe traumatic deviations. Either condition automatically results in the designation of the child as "handicapped." Because neither of these conditions was seen in the study group, they were not considered in the analysis.

Results

Of the total group of 1,413 children, 204 (14.4 percent) were clinically judged to have malocclusions of such severity as to qualify them for treatment (approved), and the remaining 1,209 children were classified as nonapproved. Means and standard deviations of component and total HLD index scores for the two groups are shown in table 1.

Percentage distributions of the HLD index scores in approved and nonapproved groups are shown in figure 1. Although the difference in group means is highly significant ($P < 0.001$), the distributions obviously are not well separated. As a consequence there is no convenient point on the scale of HLD scores which will serve to distinguish approved from nonapproved children without large misclassification errors. For example, location of the decision point at an HLD score of 13 or 14 millimeters would result in a relatively small number of false-positive classifications (approval of children who were clinically nonapproved) but would exclude from treatment nearly half of the clinically approved group. It can be seen that similar difficulties would exist at any other point on the HLD scale.

The HLD index scores shown in figure 1 are the sums of the five unweighted component measurements. It may be assumed, however, that the clinician attaches more importance to certain occlusal deviations than to others in reaching his decision as to the severity of malocclusion in each case. Accordingly, an attempt was made to achieve better separation between the distribution of index scores of the approved and nonapproved groups by the assignment of numerical weights to each component measure. For this purpose, the linear discriminant function model (*4*) was employed.

Discriminant function analysis consists of finding a function

$$Y = k_1x_1 + k_2x_2 + k_3x_3 + k_4x_4 + k_5x_5$$

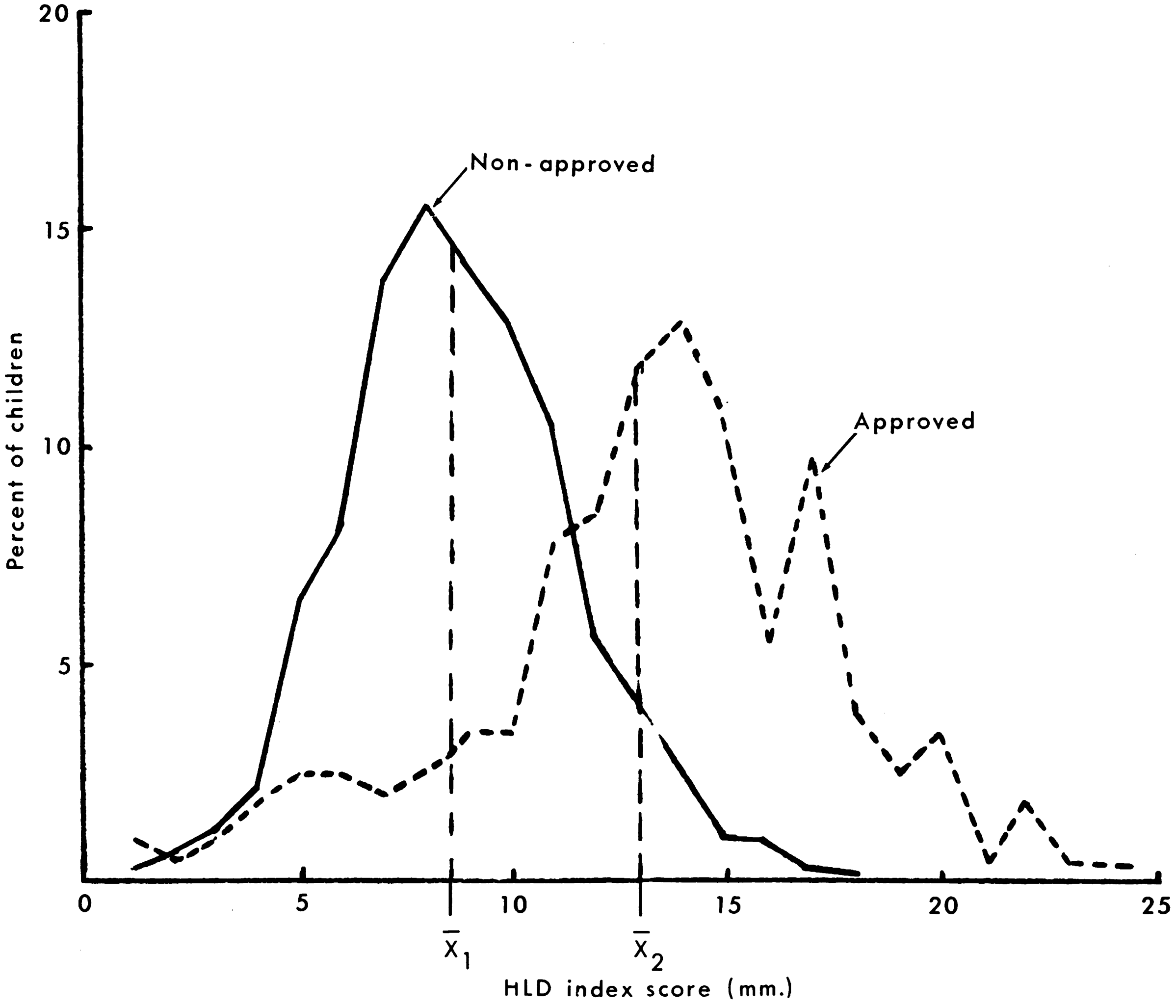
where x_1, x_2, x_3, x_4, and x_5 are the measured component scores of the HLD index and k_1, k_2,

Table 1. Mean and standard deviation of HLD scores (millimeters) of children clinically approved or nonapproved for treatment

Variable	Approved (N=204)		Nonapproved (N=1,209)	
	Mean	S.D.[1]	Mean	S.D.[1]
Total HLD scores	13. 24	4. 37	8. 78	2. 75
Overjet ($\bar{x}_1$)	6. 43	3. 37	3. 84	1. 60
Overbite ($\bar{x}_2$)	3. 85	2. 27	3. 22	1. 55
Open bite ($\bar{x}_3$)	. 18	. 73	. 03	. 02
Labio-lingual spread ($\bar{x}_4$)	2. 56	1. 70	1. 68	1. 33
Mandibular protrusion ($\bar{x}_5$)	. 22	. 83	. 01	. 26

[1] Standard deviation of the measurements.

Figure 1. Percentage distribution of HLD index scores of children clinically approved and nonapproved for treatment



k_3, k_4, and k_5 are the weighting coefficients to be determined. The coefficients k are chosen to maximize the difference $\bar{Y}_1-\bar{Y}_2$ between the mean value of the function in the approved and nonapproved groups, relative to the within group standard deviation. The computation requires the solution of a set of simultaneous linear equations.

The coefficients (table 2) were determined by using a digital computer. From these, the discriminant function Y was then evaluated for each child as

$$Y=0.069x_1+0.022x_2+0.158x_3+0.032x_4+0.197x_5$$

The mean value of the function in the two groups was

$$\text{approved group:} \quad \bar{Y}_1=0.68$$

$$\text{nonapproved group:} \quad \bar{Y}_2=0.40$$

and the difference in group means was

$$D=\bar{Y}_1-\bar{Y}_2=0.28$$

It has been shown (*5*) that the significance of the discriminant function can be tested by the analysis of variance, as shown in table 3. The F ratio of 111.7 ($P<0.001$) confirms that the distribution of the function in the two groups is significantly different. This, however, says little about the effectiveness of the function in the correct allocation of individual cases. In fact, the distributions are still considerably overlapped, as shown in figure 2, although they are somewhat better separated than the unweighted distributions.

To test the use of the HLD discriminant function, a decision point was selected at which the probability of false-positive and false-negative classifications is approximately equal. This point is located at a function value of 0.48 (fig. 2). The decision rule is that if the value of the function for a particular child equals or exceeds 0.48 he is allocated to the approved group; otherwise he is nonapproved. The probability o misclassification is approximately 20 percent in either direction and is represented by the shaded portion of figure 2.

The result of the application of this rule in the present study is shown in table 4. With the clinical decision as the standard, a total of 40+253 or 293 children were misclassified. That the two methods of decision, clinicians' and HLD discriminant function, are highly associated is indicated by the chi-square test ($P < 0.001$) of the data in table 4. However, the prospect that in the long run use of the weighted HLD measurements will lead to the "wrong" decision in one case out of five is not attractive.

Table 2. Discriminant function coefficients for component HLD scores

Variable	Coefficients
Overjet (x_1)	$k_1=0.069$
Overbite (x_2)	$k_2=0.022$
Open bite (x_3)	$k_3=0.158$
Labio-lingual spread (x_4)	$k_4=0.032$
Mandibular protrusion (x_5)	$k_5=0.197$

Table 3. Analysis of variance of the discriminant function of HLD component measurements

Source of variation	Sums of squares	Degrees of freedom	Mean square	F ratio
Between groups	50. 26	5	10. 05	111. 67
Within groups	124. 29	1, 407	. 09	------
Total	174. 55	1, 412	------	------

Table 4. Classification of clinically approved and nonapproved children by the HLD discriminant function

Clinical decision	HLD discriminant function		
	Approved	Nonapproved	Total
Approved	164	40	204
Nonapproved	253	956	1, 209
Total	417	996	1, 413

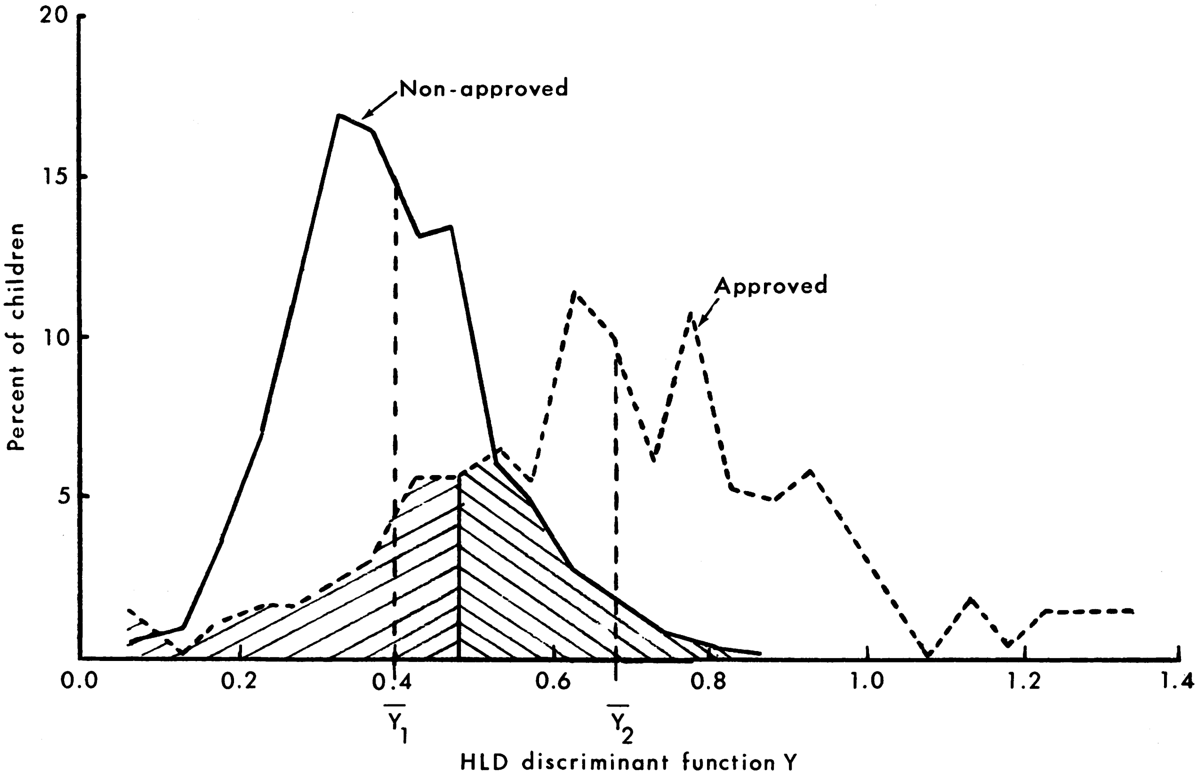
Discussion

The failure of the weighted HLD index to more closely agree with clinical judgment, although disappointing, is not greatly surprising. There is ample prior evidence to attest to the difficulties encountered in attempting to attach numerical values to either the diagnostic process or to a disease syndrome itself, particularly when the condition under study presents as many morphological variations and shadings of severity as does malocclusion.

At present, the difficulty is compounded by the fact that the clinician, although willing to make the decision that a "handicapping" malocclusion is present, is generally unable to give a precise definition of what he means by "handicapping." Possibly he considers occlusal variables other than those included in the HLD index, although the index seems reasonably comprehensive in this respect. More likely, he applies weighting factors to each variable or combination of variables that have not been mathematically identified by this analysis. By definition, the discriminant function is the best linear function of the available measurements to achieve separation of approved from disapproved groups. Some much more complex, nonlinear, function may in fact more closely resemble the clinical decision process.

The data were also subjected to a stepwise discriminant analysis in which the component variables which contributed least to the signifi-

Figure 2. Percentage distribution of HLD discriminant function scores of children clinically approved and nonapproved for treatment



cance of the function were eliminated, one by one. The results indicated that open bite and mandibular protrusion were the most effective discriminators of the five components in the sense that when either was present the probability of the child being approved was very high. This information has little practical value as these conditions are rare relative to the other components, but perhaps sheds some light on the standards applied by the clinician.

Draker (*2*) has suggested the combined use of index measurements and clinical appraisal, whereby both an upper and a lower decision point are selected and only those children whose index scores fall within this "grey area" are allocated by clinical decision. An example would be the area between the group means in figure 2. About 43 percent of the scores are located in this area. However, with a group of actual program applicants, who will be more homogenous in the severity of their malocclusions than this study's randomly selected group, the economies of this approach would need further investigation. Alternatively, the budget and staff available in a particular program may dictate the selection of a single decision point at which, for example, false-negative decisions are minimized at the expense of an increase in false-positive classifications.

The fact that decisions made by clinicians and with the HLD index differed considerably in this study implies nothing about which method is the "correct" one. Without a third standard against which to measure both, such considerations are meaningless. Much more research into the physiological and behavioral effects of malocclusion will be needed before such a study is possible.

It seems reasonable to think that the concept of "handicapping" malocclusion, although yet undefined, in some way involves the interrelation of the psychological effects of the condition on the child and the esthetic impact of his appearance on his peers. If so, there may be no numerical index based on occlusal morphology alone which will be an effective substitute for the personal evaluation of each applicant by the professional clinician.

Summary

The index of handicapping labio-lingual deviations (HLD index) is a composite occlusal index intended to assist the dental program administrator to identify children with "handicapping" malocclusions.

To evaluate its use for this purpose, the distributions of HLD index scores were determined for two groups of children who had previously been judged to have (or not to have) "handicapping" malocclusions on the basis of clinical evaluation by orthodontists. The distributions of HLD scores in the two groups were greatly overlapped.

Somewhat better separation of the distributions was achieved by the assignment of weighting constants to each of five component measurements of the HLD index, using the linear discriminant function model. With the clinical judgment as the standard, decisions made with this weighted index resulted in the "misclassification" of about 20 percent of the children when the decision point was selected to equalize false-positive and false-negative classifications.

Apparently the clinician's concept of "handicapping," although undefined, involves factors that cannot be mathematically simulated by a linear function of HLD index component scores.

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New College of Allied Health Professions

A new College of Allied Health Professions has been established at the Temple University Health Sciences Center. It will offer courses leading to a bachelor of science degree in medical technology, nursing, occupational therapy, physical therapy, and medical records library science.

The School of Medical Technology, which was founded in 1939, has been transferred to the new college. The Temple University Hospital School of Nursing, which conducts a 3-year diploma program, will not be affected immediately.

Information about enrollment in current programs and those which will be organized by 1967 is available from Dean Aaron L. Andrews, Temple University Health Sciences Center, Philadelphia, Pa. 19140. The new college will be housed in the Pharmacy and Allied Health Sciences Center which is expected to be completed in 1969.