

A comparison of two methods of assessing orthodontic treatment need in the mixed dentition: DAI and IOTN

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This paper assesses the unmet orthodontic treatment need in a random sample of 10-year-old schoolchildren, using two indices: the Dental Aesthetic Index (DAI) and the Index of Orthodontic Treatment Need (IOTN). The DAI scores were adjusted by omitting the missing teeth component of the index because many children were in the mixed dentition with unerupted permanent teeth. Although both indices assessed the same number of children with malocclusions requiring orthodontic treatment, not all were ranked similarly by each index.

Key words: Dental Aesthetic Index, Index of Orthodontic Treatment Need, malocclusion

Aust Orthod J 2000; 16: 82–7

Introduction

Two recent reports assessed orthodontic treatment need, one using the Dental Health Component (DHC) of the Index of Orthodontic Treatment Need (IOTN) and the other using the Dental Aesthetic Index (DAI), on the same sample of 10-year-old schoolchildren. Using the DHC, 31 per cent of the children were considered to need orthodontic treatment, and using the DAI, 33 per cent of the children needed treatment.^{1,2}

These indices use different methods to assess the severity of malocclusion. The DHC uses the single worst occlusal trait, selected from a list arranged in order of severity by a group of British dentists,³ and the DAI sums ten occlusal components, derived by factor analysis and stepwise regression from public opinion, to rank malocclusions on a continuous scale.⁴ When using the latter index on children in the mixed dentition, it is recommended that the missing teeth component be omitted, because permanent teeth not present in the arch are more likely to be unerupted than missing.^{5,6} This trait carries the highest weighting of the ten occlusal components assessed by the DAI.

The IOTN also includes an aesthetic component (AC). To rate dental attractiveness, both the examiner and subjects use a scale of ten photographs of different dental arrangements.⁷ The number of children assessed either by themselves or by the examiner to need orthodontic treatment on aesthetic grounds, is generally much less than the number assessed by the DHC.^{1,3,8} Because there is no satisfactory method of combining the results from the two components of the IOTN, greater emphasis has been placed on the DHC, or on clinical judgement.^{9,10}

Both indices recognise that a major benefit of orthodontic treatment is improved dental appearance and, by implication, social and psychological well-being.^{11,12} It has been suggested that the late mixed dentition is an appropriate time to screen children for orthodontic treatment,⁵ although a higher prevalence of malocclusion has been reported in younger age groups.¹³

The aim of the present study is to compare two dissimilar indices for determining orthodontic treatment need in the same randomly selected sample of 10-year-old New Zealand schoolchildren.

Subjects and methods

The subjects for this study were randomly selected from a total population of 1,405 10-year-old children attending Dunedin schools in 1995. Of the 439 children invited to participate, 309 were examined; subsequently, two children withdrew from the study, and 13 were excluded because they had had, or were having, orthodontic treatment. Of the 294 children remaining, 153 were boys (52%) and 141 were girls (48%). The mean age of the subjects was 10.5 years (range 9.9–11.3). The children were predominantly Caucasian (92%) and in the mixed dentition (93%). Details of the population and sample are given in Table I.

Table I. Random sample of 10-year-old Dunedin NZ schoolchildren

Gender	Examined	Excluded	Analysed	Age (years)	
				Mean	SD
Male	159	6	153	10.5	0.33
Female	150	9	141	10.5	0.30
Total	309	15	294	10.5	0.31

Each child was assessed by two examiners: Examiner A used the IOTN, and Examiner B, the DAI. The oral examinations were facilitated by disposable mouth mirrors, penlights, modified stainless steel rules, mylar IOTN rules and self-retaining lip retractors. No dental records or radiographs were used. The examiners were calibrated in the use of the indices on patients and study casts, prior to commencing the study. Further details of the subjects and methods used in this study have been given by Crowther *et al.*,¹ and Johnson *et al.*²

Each subject was asked by Examiner A to select the photograph from the AC scale that most closely portrayed the level of attractiveness of their teeth (Child-AC). The examiner then used the same scale to score each child's dental attractiveness (Examiner-AC). The AC grades selected by the children, and by the examiner, were grouped into the four treatment-need categories used by Otuyemi and Noar:¹⁴ Grades 1–2, no need for treatment; Grades 3–4, slight need for treatment; Grades 5–7, moderate/borderline need for treatment; Grades 8–10, great treatment need (Table II).

The DHC was assessed by selecting the worst occlusal feature listed in the DHC hierarchical scale. The recommended IOTN conventions, designed to reduce the subjectivity of the assessments, were used in this study.¹⁵ The DHC grades were divided into four treatment need categories: Grades 1–2, no/slight need for treatment; Grade 3, borderline; Grade 4, orthodontic treatment desirable; Grade 5, orthodontic treatment mandatory (Table II).

Using the recommended guidelines, Examiner B used the DAI to assess each child's occlusion.⁴ The scores for each component were multiplied by the appropriate weights, summed, and added to the constant value to calculate the standard DAI score. An adjusted DAI score was also calculated by omitting the missing teeth component from the

Table II. Classification of treatment need groups according to the AC, DHC and DAI

Index/Component		Treatment-need category		
DAI	No/Little	Elective	Desirable	Mandatory
Scores	<26	26–30	31–35	>35
AC	None	Slight	Moderate/Borderline	Great
Grades	1–2	3–4	5–7	8–10
DHC	None/Slight	Borderline	Desirable	Mandatory
Grades	1–2	3	4	5

Table III. Cross tabulations between the DAI and the Child-AC

		None 1-2		Slight 3-4		Child-AC Moderate/Borderline 5-7		Great 8-10		Total	
DAI		n	%	n	%	n	%	n	%	n	%
No/Little <26	1	29† (35)*	9.9 (11.9)	14 (20)	4.8 (6.8)	1 (2)	0.3 (0.7)	2 (2)	0.7 (0.7)	46 (59)	15.7 (20.1)
Elective 26-30	2	34 (35)	11.6 (11.9)	27 (35)	9.2 (11.9)	2 (2)	0.7 (0.7)			63 (72)	21.4 (24.5)
Desirable 31-35	3	24 (27)	8.2 (9.2)	32 (27)	10.9 (27)	11 (12)	3.7 (4.1)			67 (66)	22.8 (22.4)
Mandatory >35	4	33 (23)	11.2 (7.8)	47 (38)	16.0 (12.9)	29 (27)	9.9 (9.2)	9 (9)	3.1 (3.1)	118 (97)	40.1 (33.0)
Total		120	40.9	120	40.9	43	14.6	11	3.8	294	100

† Standard DAI

* Adjusted DAI

standard DAI. The standard and adjusted DAI scores were divided into the four orthodontic treatment-need categories proposed by Jenny and Cons:¹⁶ less than 26, little or no treatment need; 26–30, treatment elective; 31–35, treatment highly desirable; greater than 35, treatment mandatory (Table II).

To assess the reliability of the method, 28 randomly selected subjects were re-examined by the same examiners on the same day. Unweighted Kappa statistics were used to assess the reliability of the AC and the DHC.¹⁷ The repeatability of the DAI was determined with Bland and Altman's limits of agreement method.^{18,19} Associations between the Child-AC, the Examiner-AC, the DHC and the DAI were determined with Spearman's rank correlation coefficient.

Results

High intra-examiner agreements were found for both indices; however, the children's repeated self-assessments were less reproducible. The unweighted Kappa scores for the IOTN were: Child-AC, 0.66; Examiner-AC, 0.78; and DHC, 0.92. A Kappa score of 0 would indicate that any agreement between repeated observations was due to chance, and a score of 1 would indicate perfect agreement over and above that expected by chance alone. Bland and Altman's^{18,19} test revealed a consistency of ± 1.5 for the DAI scores at the 95 per cent confidence level.

Cross-tabulations between the DAI scores, both standard and adjusted, and the IOTN grades are given in Tables III to V. The tabulated results have been grouped into the treatment need categories given in Table II. The adjusted DAI treatment need categories agreed with the Child-AC categories in 31 per cent of the subjects, with the Examiner-AC in 33 per cent of subjects, and with the DHC in 35 per cent of the subjects (Tables III to V).

There were only weak correlations between the DAI and the children's self-assessments of their dental attractiveness ($r = 0.35-0.38$); moderate correlations between the DAI and the examiner's assessment of the children's dental appearance ($r = 0.55-0.58$); and stronger correlations between the DAI and the DHC ($r = 0.58-0.63$) (Table VI). In all instances, stronger associations were found between the IOTN and the adjusted DAI scores, than between the standard DAI scores.

Discussion

When these two disparate indices were used on the same group of 10-year-old children, approximately one third were considered to require orthodontic treatment by each index;^{1,2} however, not all children were ranked similarly by both indices.

The two indices use markedly different methods to rank malocclusion: the DAI uses a continuous range of scores from 13 upwards, the AC uses ten

Table IV. Cross tabulations between the DAI and the Examiner-AC

DAI		Examiner-AC									
		None		Slight		Moderate/Borderline		Great		Total	
		1-2		3-4		5-7		8-10			
		n	%	n	%	n	%	n	%	n	%
No/Little <26	1	24† (29)*	8.2 (9.9)	19 (25)	6.5 (8.5)	3 (5)	1 (1.7)			46 (59)	15.7 (20.1)
Elective 26-30	2	15 (18)	5.1 (6.1)	40 (44)	13.6 (15.0)	7 (9)	2.4 (3.1)	1 (1)	0.3 (0.3)	63 (72)	21.4 (24.5)
Desirable 31-35	3	7 (2)	2.4 (0.7)	49 (45)	16.7 (15.3)	10 (17)	3.4 (5.8)	1 (2)	0.3 (0.7)	67 (66)	22.8 (22.4)
Mandatory >35	4	7 (4)	2.4 (1.4)	46 (40)	15.6 (13.6)	56 (45)	19.0 (15.3)	9 (8)	3.1 (2.7)	118 (97)	40.1 (33.0)
Total		53	18.1	154	52.4	76	25.8	11	3.8	294	100

† Standard DAI

* Adjusted DAI

subjectively determined grades, and the DHC, five subjectively determined grades. Richmond *et al.*¹⁵ recommended three categories of treatment need for the DHC and the AC; however, in order to facilitate comparison with the DAI, the AC grades were grouped into the four AC categories used by Otuyemi and Noar,¹⁴ and the DHC grades into four DHC categories.

The weakest association between any of the components of the IOTN and the adjusted DAI was found with the Child-AC ($r = 0.38$, Table VI). Complete agreement between the Child-AC and DAI treatment need categories occurred in only 31 per cent of subjects, and 69 per cent fell within plus or minus one category of outright agreement (Table III). Holmes and Willmot¹⁰ reported that children have difficulty grasping the concept of using the AC as a severity scale, and that many children attempted to match their own dental arrangement with one of the photographs. The large number of disagreements between the Child-AC and the adjusted DAI may be due to this and, perhaps, because recent changes in their own dentitions made them uncertain of their dental appearance. Others have reported that, compared with assessments by orthodontists, children using the AC tend to overrate their dental appearance.^{3,10} This is supported by Crowther *et al.*,¹ who reported that none of the children in the present study assigned to a treatment grade by the Examiner-AC, assessed themselves as needing orthodontic treatment.

In agreement with Otuyemi and Noar,¹⁴ we found moderate correlations between the standard DAI and the Examiner-AC (Table VI). However, outright agreement between the adjusted DAI and

the Examiner-AC treatment categories occurred in only 33 per cent of our subjects, compared with 60 per cent reported by Otuyemi and Noar.¹⁴ It could be argued that the higher number of agreements in their study was due to their biased sample: they examined the dental casts of 53 randomly selected 11- to 16-year-old orthodontic patients for whom orthodontic need had already been established. In the present study, 82 per cent of subjects were within plus or minus one category of complete agreement (Table IV).

Both the standard and adjusted DAI were more strongly correlated with the Examiner-AC than with the Child-AC, but only 4 per cent of the subjects were judged by the Examiner-AC to need orthodontic treatment, compared with 33 per cent assessed by the adjusted DAI. Conversely, 7.5 per cent of the cases identified as not requiring any treatment by the Examiner-AC fell into the mandatory treatment group of the adjusted DAI.

The highest correlation was found between the adjusted DAI scores and the DHC grades (Table VI): 35 per cent of the subjects fell into the same treatment need category, and 82 per cent were within plus or minus one category of complete agreement (Table V). Slightly more than half of the subjects assessed by the DHC to require no/little treatment fell into one of the three treatment categories when assessed by the adjusted DAI. Of these, 6 per cent were in the mandatory treatment group. At the other end of the scale only 29 per cent of the cases that fell into the DHC mandatory treatment group were not in the same adjusted DAI category. These findings lend support to Keay *et al.*,⁵ who reported that the DAI correctly predicts a high proportion of subjects requiring treatment,

Table V. Cross tabulations between the DAI scores and the DHC

DAI		DHC									
		None/Slight		Borderline		Desirable		Mandatory		Total	
		1-2		3		4		5		n	%
		n	%	n	%	n	%	n	%	n	%
No/Little	1	33†	11.2	12	4.1	0	0	1	0.3	46	15.6
<26		(41)*	(13.9)	(16)	(5.4)	(1)	(0.3)	(1)	(0.3)	(59)	(20.1)
Elective	2	34	11.6	25	8.5	3	1.0	1	0.3	63	21.4
26–30		(36)	(12.2)	(28)	(9.5)	(7)	(2.4)	(1)	(0.3)	(72)	(24.5)
Desirable	3	17	5.8	34	11.6	13	4.4	3	1.0	67	22.8
31–35		(14)	(4.8)	(32)	(10.9)	(14)	(4.8)	(6)	(2.0)	(66)	(22.4)
Mandatory	4	13	4.4	34	11.6	48	16.3	23	7.8	118	40.1
>35		(6)	(2.0)	(29)	(9.9)	(42)	(14.3)	(20)	(6.8)	(97)	(33.0)
Total		97	33.0	105	35.8	64	21.9	28	9.4	294	100

† Standard DAI

* Adjusted DAI

but has a tendency to overestimate treatment need. They also concluded that a DAI “no treatment” decision is likely to be correct.

The tendency for the DAI to overestimate treatment need is greater in the mixed dentition, because many children have temporary occlusal conditions, such as an edge-to-edge molar relationship, incisal spacing, or diastemata, all of which attract a score but may improve spontaneously in the transition to the permanent dentition. The adjusted DAI compensates for only one of these temporary conditions and, as a result, the proportion of children considered to need orthodontic treatment was still higher than that found in older age groups using the standard DAI.^{4,13,16,20,21} The DHC, on the other hand, because it records only the single worst occlusal feature, may also incorrectly estimate treatment need: a child with a number of occlusal conditions could receive a low DHC grade, although the malocclusion as a whole may be severe enough to warrant treatment or, conversely, a subject with a single localised tooth malposition may be assessed as having great treatment need. The worst occlusal feature also is scored for each of the ten DAI occlusal components, but the effect on the total score is much less than in the DHC. Thus, in their current forms, both indices may be inappropriate to assess orthodontic treatment need in the mixed dentition.

The choice of cut-off points for the treatment need categories in both indices was based on the subjective opinions of clinicians^{3,15,16,21} and, consequently, direct comparison of the categories in

Table VI. Spearman's rank-order correlation coefficients between the DAI and IOTN

	Child-AC	Examiner AC	DHC
Standard DAI scores	0.370	0.566	0.603
DAI treatment categories	0.351	0.549	0.584
Adjusted DAI scores	0.383	0.585	0.625
Adjusted DAI treatment categories	0.371	0.563	0.602

the two indices is problematical. In the final analysis, decisions about who will receive orthodontic treatment in a public health setting are likely to be made on the availability of funding. As the DAI ranks subjects on a continuous scale, selection of a cut-off point is relatively simple; whereas, the IOTN, with just four categories, has limited specificity when funding allocations fall within a treatment group.

Acknowledgments

The study was supported by a grant from the Dean's HRC Fund. We thank Mrs Gwen Hudson, Dental Manager, Community Health Services, Healthcare Otago, and the Dunedin school dental therapists who willingly assisted in gathering the sample for this study; and the School of Dentistry staff who helped with both the organisation and the examinations.

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