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Original Article

Age changes in orthodontic treatment need: a longitudinal study of 10- and 13-year-old children, using the Dental Aesthetic Index

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The Dental Aesthetic Index (DAI) was used to assess the prevalence of unmet orthodontic treatment need in 150 13-year-old schoolchildren in Dunedin, New Zealand, and to compare the findings with those obtained in the same children at 10 years of age.
Fewer 13-year-olds (27%) had a "mandatory" need of orthodontic treatment than when they were 10 years old (33%), 20% had "no/little" need for orthodontic treatment, 33% had an "elective" need for treatment and 20% had a "desirable" need for treatment. The fall in DAI scores is attributed to over-sensitivity of the Index to mixed dentition traits.
When the individual scores were analysed, only 7% of the 10-year-olds were given the same scores as when they were 13 years old, 52% were given higher scores and 41% were given lower scores. This disagreement between scores was masked to a limited extent by the DAI categories: 49% of the 10-year-olds were assigned to the same DAI category at 13 years of age, 20% to a greater treatment-need category and approximately 30% to a lower treatment-need category.
The DAI, in common with other malocclusion indices, is unreliable over time because it is affected by developmental changes in the occlusal traits measured.
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Introduction

Of the indices developed to assess orthodontic treatment need, the majority have evaluated only the alignment and occlusion of the teeth.[1,2] The few indices that have assessed dental appearance have, as a rule, relied on the subjective opinions of professionals: only the Dental Aesthetic Index (DAI) is based on the opinions of members of the public.[3–5]

The DAI was designed to be used in the permanent dentition; however, a recent modification has been proposed to enable it to be used in the mixed dentition.[3,6,7]

The DAI consists of ten measures of intra-oral occlusal traits that are multiplied by a rounded regression coefficient to which a constant is added. The total score is then classified into one of four treatment-need groups, or rank-ordered against other DAI scores on a continuous scale: "no/little" treatment need (< 26); treatment "elective" (26–30); treatment "highly desirable" (31–35); and treatment "mandatory" (> 35).[7] Further details of DAI scores are given by Johnson and Harkness.[8]

In a previous study using the standard DAI on a predominantly mixed dentition sample, orthodontic treatment was considered "mandatory" in 40 per cent of the children.[8] This high level of "need" was due largely to the presence of a number of developmental conditions, such as unerupted teeth, and fell to 33 per cent when the "missing teeth" component was omitted.[6,8] This finding, using the DAI without the "missing teeth" component, was in close agreement with the Index of Orthodontic Treatment Need (IOTN) findings on the same children.[9] Otuyemi and Jones[10] are of the opinion that the tendency of the DAI to overestimate treatment need in mixed dentition samples limits its utility. On the other hand, it has

Table I. The number of children analysed in the 1995 and 1998 surveys.

Year	Gender	Population	Sample	Examined	Excluded†	Analysed	Age(Years)	SD
1995	Boys	-	-	159	6	153	10.5	0.33
	Girls	-	-	150	9	141	10.5	0.30
Total		1,405	439	309	15	294	10.5	0.32
1998	Boys	-	-	95	23	72	13.4	0.30
	Girls	-	-	104	26	78	13.4	0.26
Total		-	294	199	49	150	13.4	0.28

† Orthodontic treatment

been argued that, because some conditions are better treated in the mixed dentition, a screening method should be applicable at the "optimum treating age".[6]

Remarkably few studies have attempted to determine the age changes, if any, in orthodontic treatment need as assessed using the DAI. Some[11] have examined study models of subjects in older age groups whilst others have examined several age groups cross-sectionally.[12] A search of the English-language literature revealed no reports of longitudinal studies using the DAI on children.

The aims of this study were, first, to determine with the DAI the unmet orthodontic treatment need in 13-year-old Dunedin, New Zealand, schoolchildren and, second, to compare the findings with those obtained from the same children at 10 years of age. These children were part of a larger sample of 10-year-olds used to determine orthodontic treatment need.[8,9,13]

Subjects and methods

Ethical approval for this study was granted by the Ethics Committee of the Southern Regional Health Funding Authority, in New Zealand. The subjects in the survey were 13-year-old children, originally randomly selected from 1,405 10-year-olds enrolled at primary and intermediate schools in the Greater Dunedin area in 1995, who either had not had or were not having orthodontic treatment when they were re-examined in 1998.[8,9] Of the 439 children who were invited to participate in 1995, 309 consented to be examined. Of these, two withdrew from the study and thirteen were having or had had orthodontic treatment; leaving 294 10-year-olds. Of the 294 eligible subjects, 183 (62.2%) consented to be re-examined in 1998, and sixteen who were not examined were found to have either received or to be undergoing orthodontic treatment. The remaining 95 subjects either could not be contacted, refused to be re-examined, or had moved out of the Dunedin area. Of the 183 children who consented to be re-examined, 33 (18.0%) had had or were having orthodontic treatment, leaving 150 (82.0%) who had not received orthodontic treatment. A total of 49 children were known to have received orthodontic treatment (Table I).

The subjects were examined either at the schools they attended or in the orthodontic clinic of the School of Dentistry at the University of Otago, in New Zealand. Two clinicians were used, one of whom (Examiner B) had examined the children in 1995. Examination of the teeth was aided by disposable mouth mirrors and modified steel rules. The materials used and methods employed were identical to those used in 1995.[8,9]

The DAI was administered according to the standard conventions.[3]

Prior to commencing the survey, both examiners were calibrated in the use of the DAI on study casts. Examiner A (who did not take part in the 1995 survey) re-examined 25 schoolchildren who were not part of the study; comparison revealed that the examiner's first and second scores were within ± 3.3 of his averaged score, at the 95 per cent limits of agreement. Examiner B's repeat assessments[8] were ± 1.5 of his averaged score, at the 95 per cent limits of agreement.[14] Inter-examiner correlation was tested by comparing the scores for the 120 children assessed by both examiners, and showed that they were within ± 7.0 of their averaged score at the 95 per cent limit of agreement. As there was moderate agreement between the examiners, the mean scores of the 13-year-old children as assessed by both examiners were used.

Table II. DAI component scores for the same 10- and 13-year-old children.

Component	Age	Score							Total	Sig.
	(years)	0	1	2	3	4	5	6		
Missing Teeth	10	125	18	7	-	-			150	
	13	136	9	3	1	1			150	
No. of Crowded	10	32	63	55					150	**
Segments	13	21	45	84					150	
No. of Spaced	10	56	84	10					150	***
Segments	13	109	34	7					150	
Diastema (mm)	10	88	26	20	13	2	1		150	***
	13	124	10	14	1	1	-		150	
Maxillary	10	37	45	33	26	7	2	-	150	***
Irregularity (mm)	13	10	29	76	18	12	2	3	150	
Mandibular	10	25	73	35	12	4	0	1	150	*
Irregularity (mm)	13	22	49	56	15	6	2	-	150	
Maxillary	10	63	68	17	2				150	*
Overjet (mm)†	13	51	85	8	6				150	
Mandibular	10	145	3	2	-	-	-		150	
Overjet (mm)	13	142	1	5	1	0	1		150	
Openbite	10	143	0	5	1	0	1		150	
	13	143	3	4	-	-	-		150	
Molar Relationship	10	64	66	20					150	
	13	74	52	24					150	

χ^2, 1995 versus 1998, $^*p \leq 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

† maxillary overjet measured in groups: 0–3mm, 4–6mm, 7–9mm, 10–14mm

The Chi-square test was used to test the distribution differences between the sexes, the age differences in the DAI scores, the DAI component scores, and the differences between those 10-year-olds who as 13-year-olds received orthodontic treatment and those who did not.

Results

There was no significant difference between the DAI scores for the 13-year-old boys and girls (p = 0.6423). The mean DAI scores for the 13-year-old children was 31.8 (SD 8.2); 31.8 (SD 6.9) for boys and 31.8 (SD 6.9) for girls. The mean change in the DAI scores for the children examined at both 10 and 13 years of age was -0.7 (SD 7.1). The changes in the DAI scores between 10 and 13 years ranged from -22 to 29 (Figure 1).

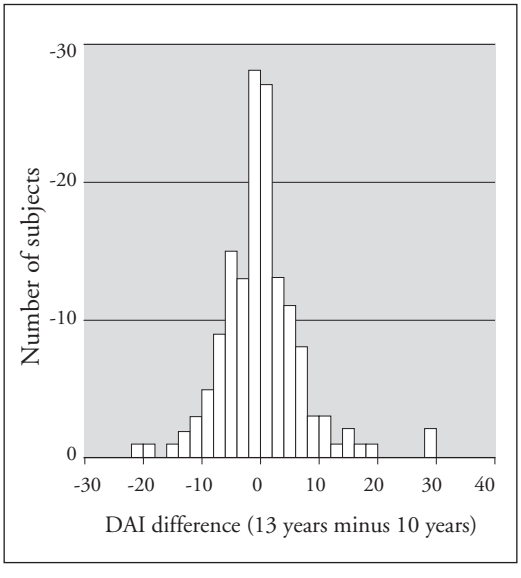

Figure 1. Differences in DAI scores for the same children at 10 and 13 years of age.

Table III. DAI categories for the same 10- and 13-year-old children.

Category	Boys†				Girls†				Combined†			
	10 yrs		13 yrs		10 yrs		13 yrs		10 yrs		13 yrs	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
No/Little (≤25)	11	15.3	12	16.7	19	24.4	18	23.1	30	20.0	30	20.0
Elective (26-30)	14	19.4	24	33.3	21	26.9	26	33.3	35	23.3	50	33.3
Desirable (31-35)	17	23.6	17	23.6	18	23.1	13	16.7	35	23.3	30	20.0
Mandatory (≥36)	30	41.7	19	26.4	20	25.6	21	26.9	50	33.3	40	26.7
Total	72	100.0	72	100.0	78	100.0	78	100.0	150	100.0	150	100.0

†χ^2; Boys 10 yrs versus boys 13 yrs, $p = 0.1615$

χ^2; Girls 10 yrs versus girls 13 yrs, $p = 0.7079$

χ^2; Combined 10 yrs versus combined 13 yrs, $p = 0.2465$

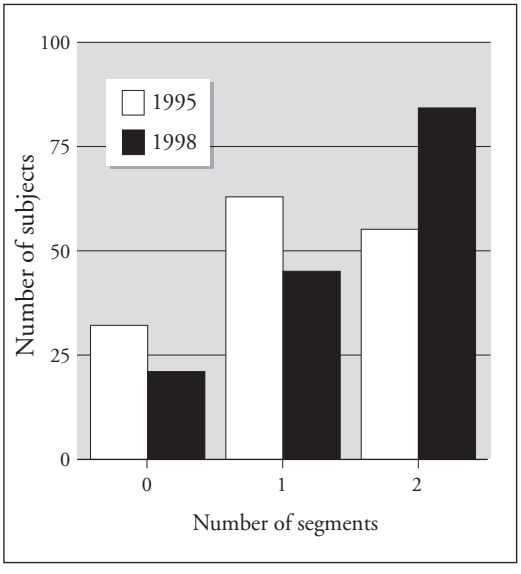

Figure 2. Distribution of the number of crowded segments.

The DAI component scores for the boys and girls combined are given in Table II. Highly significant ($p < 0.001$) differences were found in the distribution of subjects in the number of spaced segments, diastema and maxillary irregularity (Figures 2 to 5). The distributions of subjects in the number of crowded segments ($p < 0.01$), mandibular irregularity ($p < 0.05$) and maxillary overjet ($p < 0.05$) were also significantly different. Frequency distributions of the highly significant findings are shown in Figures 2 to 5. Incisal segment crowding increased in approximately 25 per cent of the children between 10 and 13 years of age (Table II, Figure 2). Incisal segment spacing decreased between 1995 and 1998 in 39 per cent of the children (Table II, Figure 3). Midline diastemas tended to close between 10 and 13-years-of age (Table II, Figure 4). The mean decrease in the size of midline diastemas was 0.5 mm. Midline diastemas closed at least 1 mm in 32 per cent of the children but in the majority (64.7%) there was no change (Table II, Figure 4). The mean largest maxillary irregularity increased by 0.6 mm between 10 and 13 years of age. In over half of the children (50.7%), the largest maxillary irregularity increased 1 mm and in 20 per cent, maxillary irregularity increased by at least 2 mm (Table II, Figure 5).

The distributions of the same 10- and 13-year-old children by treatment-need category are given in Table III. Although more girls were considered to have a "desirable" need for treatment in 1995 (23.1%) as compared with 1998 (16.7%), and fewer were considered to have an "elective" need for treatment in 1995 (26.9%) compared with 1998 (33.3%), there was no significant difference in the distributions ($p = 0.708$). Similarly, there was no significant difference in the distributions of the boys in the four categories. There was, however, a large drop in the number of 13-year-old boys with a "mandatory" need for treatment (41.4% of 10-year-olds compared with 26.4% of 13-year-olds). When the boys and girls were combined, the distributions of 10- and 13-year-olds in

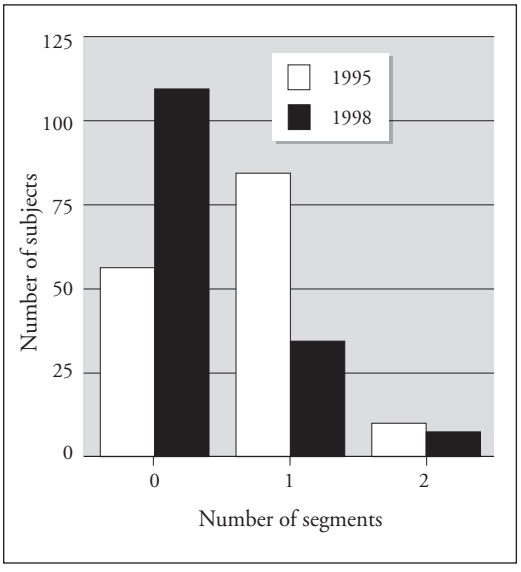

Figure 3. Distribution of the number of spaced segments.

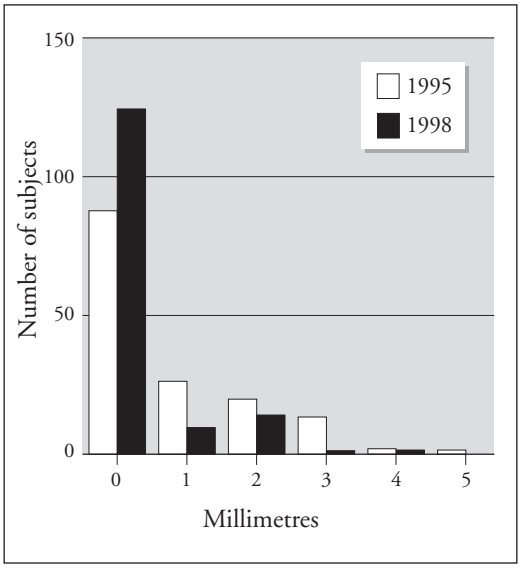

Figure 4. Distribution of the midline diastema space, in millimetres.

the four categories were not significantly different ($p = 0.2465$). In relation to the treatment-need categories, there were no statistically significant differences between the distributions of children who had received orthodontic treatment by 1998 and those who had not received orthodontic treatment (boys: $p = 0.0589$; girls: $p = 0.2814$).

Approximately half of the 150 children who were examined at 10 years of age were in the same treatment-need category at 13 years of age: exactly one fifth ($n = 30$) moved into a higher treatment-need category while approximately one third ($n = 47$: 31.3%) were assessed as having a lesser need for treatment. However, when the DAI scores, as opposed to the treatment-need categories, are examined, only 7.3% ($n = 11$) of the children were assigned the same score at both 10 and 13 years of age. Over half of the children ($n = 78$: 52.0%) were assigned to a higher DAI score, whilst approximately two fifths ($n = 61$: 40.7%) received a lower DAI score.

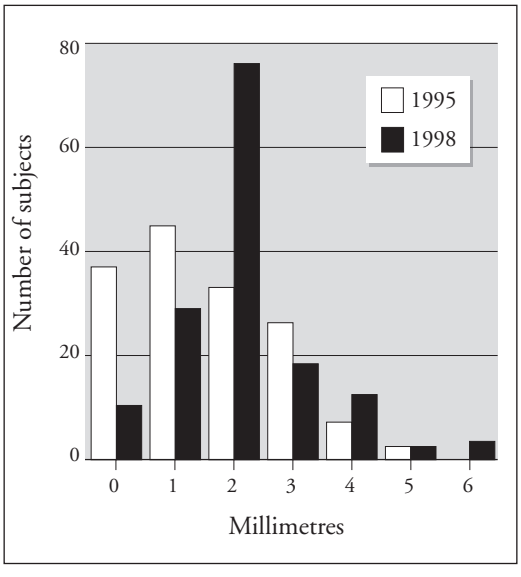

Figure 5. Distribution of the largest maxillary irregularity, in millimetres.

Discussion

The DAI was originally developed to screen individuals seeking publicly-funded orthodontic treatment.[3] It is the product of extensive statistical testing and can thus be considered a "robust" instrument.[15] However, it was not developed for use on children in the mixed dentition because it was believed that transient developmental conditions may confound the results.[6,15] In the present study, the mean difference in DAI scores between the children assessed at 10 and 13 years of age was only -0.7, suggesting that the DAI is less influenced by developmental conditions than previously thought.[12] Furthermore, when the four treatment-need categories were analysed, complete agreement occurred in 49 per cent of the children assessed at both ages, compared with complete agreement in 43 per cent of the same children when the Dental Health Component of the IOTN was used.[16] However, when the scores assigned to individual children were compared, complete agreement occurred in only 7 per cent of the

sample. In common with the IOTN, the size of the treatment-need categories masked movement of children to different scores within the same category.

The DAI, although less popular than the IOTN, has a number of advantages. Its assessment of the ten occlusal traits provides more clinical information than indices based on a single worst feature. If a number of conditions are present, it is less likely to underestimate the severity of a malocclusion.[9,16] It also provides more flexibility when assigning the final scores to the treatment-need categories. The clinician may use different weights from those proposed,[17] and may alter the cut-off point between individuals needing treatment and those who do not;[18] in common with the IOTN, the cut-off points between the various categories are determined by the subjective opinions of orthodontists.[15] Although the IOTN has fewer treatment-need categories than the DAI, a previous study found the latter index to be slightly more stable over time: fewer 10-year-olds were assigned to higher treatment-need categories than they were as 13-year-olds.[16]

In the present study, the standard DAI conventions were used. The number of 10-year-olds who were assessed with a "mandatory" need for treatment by 13 years of age fell by 7.5 per cent. The fall in the proportion of boys "needing/not needing" treatment was more marked: 15 per cent fewer boys "needed" treatment at 13 years of age than at 10 years of age. The boys also had a significantly higher DAI score than the girls at 10 years of age; a difference that was lost when the "missing teeth" component was omitted.[8]

In the present study, a higher percentage of children with crowded segments and maxillary irregularity, and a smaller percentage of children with spacing and a midline diastema occurred at 13 years of age. Age changes in these components may be attributed to the emergence of the maxillary canines. The size of the midline diastema and the component assessing the number of "missing teeth" carry high weights. Along with the significant age-related reduction in overjet, these may also contribute to the DAI's instability over time.[11,19]

The mean DAI score in the present study was markedly higher than that reported for 11- to 16-year-old children in an Australian cross-sectional study.[12] However, as subjects who had received orthodontic treatment were included in the Australian study, the results are likely to be biased. It would be reasonable to expect that orthodontic treatment would reduce the DAI score in individual children and if sufficient children had had orthodontic treatment, the mean DAI score also would be affected. Tarvit and Freer[11] also reported that the mean DAI score fell between 12 and 16 years of age, but omitted to give the actual figures.

If treatment-need decisions for our sample had been based on the "mandatory" results obtained for 10-year-olds, [8] then by 13 years, 8 per cent of children who required treatment would not have received treatment and a further 14 per cent would have been treated unnecessarily. Assessment of treatment need in the mixed dentition is difficult, but desirable, because some types of treatment are better carried out in the mixed dentition stage of dental development.[6] Further work is required to identify those conditions present in the mixed dentition that will require treatment as opposed to those that should be treated in the permanent dentition. Because the DAI assesses ten components and has a high negative predicting power, indicating that a no-treatment recommendation is likely to be correct, future studies should concentrate on the subjects considered to need treatment. Our results indicate that 22 per cent of the treatment-need decisions made at 10 years of age were altered at 13 years of age. This may have serious consequences if the DAI is used to allocate limited orthodontic resources in an equitable fashion.

There is also a need to re-validate any index that is used over a period of time, especially one that is applied to different population groups.[20] Public perceptions of malocclusion may differ between countries and cultures, as well as between age groups.[21] The opinions used to develop an index may not be valid for different population groups. Indices such as the IOTN are not easily modified for different demographics; whereas the DAI has an advantage in that it assesses a number of occlusal conditions and provides raw data that can be adjusted for different population groups.

Overall, the performance of the DAI in this sample is good when compared with other indices.[16] It is slightly less sensitive to mixed dentition developmental traits than the IOTN and more easily modified to suit different circumstances.[8]

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