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A comparison of two orthodontic aesthetic indices

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Objectives: A cross-sectional study was conducted to determine the level of agreement between the Dental Aesthetic Index (DAI) and the Aesthetic Component (AC) of the Index of Orthodontic Treatment Need (IOTN).

Methods: DAI and AC scores were recorded in 728 subjects (340 females and 388 males, aged 11-20 years). The percentage of subjects needing treatment and the different treatment categories for the DAI and AC were gender compared. Spearman's rank correlation coefficient (rho) was used to explore the relationship between the DAI and AC scores. Observer determined and Kappa statistics were used to analyse the diagnostic level of agreement between the DAI and AC, sorted into 'yes' or 'no' categories of orthodontic treatment need.

Results: According to the DAI and AC, 21.8 and 10.9% of subjects were in need of treatment, respectively. Significant positive correlations existed between the DAI and AC scores (rho = 0.795). The DAI had a lower treatment need threshold compared with the AC. The Kappa statistics and percentage agreement between the DAI and AC was 0.55 (95% CI: 0.46-0.63) and 87.6%, respectively.

Conclusion: The DAI and AC showed strong association. However, only a moderate level of diagnostic agreement was identified (12.4% difference in observed percentage agreement) which highlights the need for a unified and universal orthodontic index for consideration when interpreting, comparing, or quantifying treatment needs.

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Introduction

Establishing orthodontic services to address treatment requirements in any population is based on an estimate of need and demand. Several occlusal indices have been developed in an attempt to place malocclusions into categories according to a level of severity and orthodontic treatment need.[1] The Standardized Continuum of Aesthetic Need (SCAN) index[2] and the Dental Aesthetic Index (DAI)[3] have concentrated on the aesthetic aspects of occlusion. Brook and Shaw[4] used a modified version of the SCAN index and incorporated it into the Index of Orthodontic Treatment Need (IOTN) as an Aesthetic Component (AC). The AC consists of a 10-point scale, illustrated by a series of frontal intra-oral photographs of dentitions that were rated for attractiveness by a panel of lay judges. Photographs were given a score from 1 to 10 depending on the attractiveness of the malocclusion.[2]

The DAI mathematically links its clinical and aesthetic components to produce a single score, which reflects malocclusion severity.[3] The development of the DAI was based on a social acceptability scale of occlusal conditions.[5] Its development employed regression procedures based on a sample of 200 photographs of occlusal configurations, selected by a disproportionate, stratified, random sampling procedure from a larger sample of 1337 study models

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Table I. DAI components and the rounded weights.

DAI	Component	Rounded weights
1	Number of missing visible teeth (incisors, canines, and premolars in the maxillary and mandibular arches)	6
2	Assessment of incisal segment crowding: 0 = no segments crowded; 1 = 1 segment crowded; 2 = 2 segments crowded	1
3	Assessment of incisal segment spacing: 0 = no segment spaced; 1 = 1 segment spaced; 2 = 2 segments spaced	1
4	Midline diastema (mm)	3
5	Largest anterior irregularity on the maxilla (mm)	1
6	Largest anterior irregularity on the mandible (mm)	1
7	Anterior maxillary overjet (mm)	2
8	Anterior mandibular overjet (mm)	4
9	Vertical anterior open bite (mm)	4
10	Assessment of antero-posterior molar relation; largest deviation from normal either left or right: 0= normal; 1 = ½ cusp either mesial or distal; 2 = full cusp or more either mesial or distal	3
11	Constant	13
		Total DAI score

(collected from high school students in New York state, aged 15-18 years).[5,6] The regression procedures provided the statistical basis for the coefficient weightings used against 10 selected occlusal traits.[5,6] The DAI used a regression equation that required the measured components of the DAI to be multiplied by their regression coefficients (weightings), the addition of their products and of a constant to provide a total as the DAI score (Table I). Subsequently, this score was used to determine the need for orthodontic treatment[7] and has been included in the World Health Organization Oral Health Survey Methods (1997).

Orthodontic treatment need indices have enabled the prioritisation of treatment. However, indices vary, are not always comparable[8-10] and do not necessarily select a similar number of patients for treatment.[1] The DAI and AC have been found to be regionally valid, but some authors[11] suggested adjusted cut-off points. Few studies have objectively compared the DAI and the AC[12,13] and of those, small sample sizes provided an insufficient variety of malocclusion to adequately assess index relationships. A recent study[14] assessed the agreement between the DAI and a modified IOTN. While the study sample size was considerably larger, diagnostic agreement between the DAI and the Aesthetic Component of IOTN (AC) provided no insight of treatment need. Even though a significant association was reported between these two indices,[12,13] Manzanera and colleagues[14] assessed the three grades of the AC and four grades of the DAI and reported a low level of agreement (using Intraclass Correlation Coefficients). Therefore, the aim of the present study was to assess the relationship and diagnostic agreement between the AC (IOTN) and the DAI. An additional aim was to determine the effect of newly suggested cut-off points on the diagnostic agreement level between the two indices.[11]

Materials and methods

Study design and study sample

The present cross-sectional study was approved by the Research Ethics Committee and Faculty of Community Dentistry, School of Dentistry, Isfahan University of Medical Sciences. The target population consisted of urban Iranian schoolchildren, aged 11-20 years in Isfahan. This age group represented the permanent dentition and a time when the majority of orthodontic problems become evident. The exclusion criteria involved subjects with craniofacial anomalies (clefts and syndromes) and non-Iranian nationals. To ensure randomness, 40 public schools

were chosen using a stratified selection technique from different geographic locations in the city and 728 schoolchildren (340 females and 388 males) participated in this survey.

Aesthetic component of the IOTN

The Aesthetic Component of the IOTN (AC)[4] consists of a scale of 10 colour photographs, which display increasingly worsening levels of dental attractiveness. Grade 1 represents the most attractive and Grade 10 the least attractive dentition.

Dental Aesthetic Index (DAI)

The DAI[3] records 10 occlusal traits related to dentofacial anomalies and is calculated according to the criteria shown in Table I. To determine the need for orthodontic treatment, the final DAI score was categorised into four malocclusion severity levels. Two examiners were trained by an instructor (AF) in the use of the AC and also in the use of the DAI. Substantial agreement was subsequently observed between the examiners (Kappa > 0.80) who visited the selected schools and recorded the DAI and AC by clinical examinations using a mouth mirror, ruler and a digital sliding caliper.

Statistical analysis

The collected data were entered into the SPSS 17 program (Statistical Package for Social Sciences, SPSS Inc., Chicago, IL, USA) which provided descriptive statistics. Confidence Intervals (CI) of the average DAI scores were calculated for both genders. The number of subjects in each treatment need category for the DAI (No treatment, Treatment elective, Treatment desirable and Treatment mandatory) and the AC (No/little need, Borderline need and Definite need) was compared according to gender, using the Chi-square test. Spearman rank correlation coefficients (rho) were also applied to explore the relationship between the DAI and AC scores.

Kappa statistics were used to analyse the diagnostic agreement between the DAI and AC dichotomised into 'yes' or 'no' categories of orthodontic treatment need. A kappa of 1 indicated perfect agreement, whereas a kappa of 0 indicated agreement equivalent to chance. The agreement was defined using the following scale described by Altman:[15]

Poor agreement - less than 0.20

Fair agreement - 0.20 to 0.40

Moderate agreement - 0.40 to 0.60

Good agreement - 0.60 to 0.80

Very good agreement - 0.80 to 1.00

The effect of suggested cut-off points of 28 and 5 for the DAI and AC, respectively[11] was investigated and the diagnostic agreement calculated.[11] P values less than 0.05 were interpreted as statistically significant.

Results

The mean (95% CI) DAI score for the study sample was 26.14 (25.60 - 26.72) points. The mean (SD) DAI scores of male and female subjects were 26.90 (8.28) and 25.28 (6.75), respectively (Figure 1).

Tables II and III summarise the distribution of the AC and DAI treatment need categories in the study sample. The Aesthetic Component of the IOTN (AC) classified 10.9% of subjects (14.7% of males and 6.5% of females) with a definite need for treatment, 29.4% a borderline need and 59.8% with slight or no need for treatment (Table II). The need for treatment (AC) varied significantly between the genders (Chi-square = 12.65, df = 1, p < 0.05). According to the DAI, 21.8% of subjects (24.0% of males and 19.4% of females) needed orthodontic treatment and the need for treatment did not vary significantly between the genders (Chi-square = 2.20, df = 1, p > 0.05).

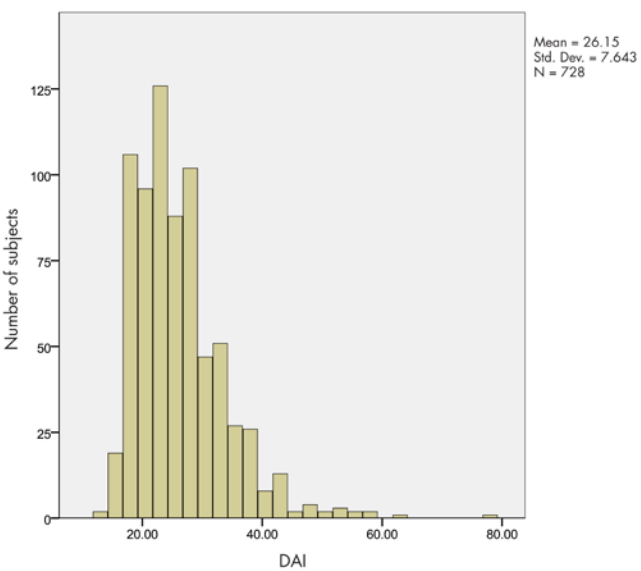


Figure 1. Distribution of DAI scores in the study sample.

Table II. Gender distribution (%) of different AC (IOTN) treatment need categories in the study sample.

		Gender		Total
		Male	Female	
AC (IOTN) treatment need category	1-4	209 (53.9)	226 (66.5)	435 (59.8)
	5-7	122 (31.4)	92 (27.1)	214 (29.4)
	8-10	57 (14.7)	22 (6.5)	79 (10.9)
	Total	388	340	728

Chi-square =17.28, df = 4, $p < 0.001$

Table III. Gender distribution (%) of different DAI treatment need categories in the study sample.

DAI Treatment need category		Gender		Total
		Male	Female	
= < 25	No treatment need/slight need	196 (50.5)	201 (59.1)	397 (54.5)
26-30	Treatment elective	99 (25.5)	73 (21.5)	172 (23.6)
31-35	Treatment highly desirable	40 (10.3)	40 (11.8)	80 (11.0)
> = 36	Treatment mandatory	53 (13.7)	26 (7.6)	79 (10.9)
Total		388	340	728

Chi-square =10.10, df=3, $p < 0.05$

Table IV. Contingency table showing distribution (%) of different treatment need categories using the DAI and AC (IOTN).

		AC (IOTN) treatment need categories			Total
		1-4	5-7	8-10	
DAI treatment need categories	= < 25	352 (80.9)	45 (21.0)	0	397 (54.5)
	26-30	65 (14.9)	102 (47.7)	5 (6.3)	172 (23.6)
	31-35	11 (2.5)	46 (21.5)	23 (29.1)	80 (11.0)
	> = 36	7 (1.6)	21 (9.8)	51 (64.6)	79 (10.9)
	Total	435	214	79	728

Chi-Square = 536.77, df = 4, $p < 0.01$

Table V. Contingency table showing the determination of orthodontic treatment need (%) using the DAI and AC (IOTN).

		AC (8-10)		Total
		No	Yes	
DAI (> 30)	No	564 (86.9)	5 (6.3)	569 (78.2)
	Yes	85 (13.1)	74 (93.7)	159 (21.8)
Total		649	79	728

Chi-Square = 267.84, df = 1, $p < 0.01$
Observed percentage agreement = 87.6%
Kappa value = 0.558, SE = 0.040, $p < 0.01$

Table VI. Distribution (%) of subjects with different AC (IOTN) treatment need categories according to the DAI treatment need (DAI > 30).

		DAI > 30		Total
		No	Yes	
AC (IOTN) treatment need category	1-4	417 (95.9)	18 (4.1)	435
	5-7	147 (68.7)	67 (31.3)	214
	8-10	5 (6.3)	74 (93.7)	79
Total		569 (78.2)	159 (21.8)	728

Nearly half of the subjects (54.5%) showed no or a slight need for treatment (DAI < 25) and 23.6% had elective treatment need (25 < DAI < 30). However, in 11.0% of subjects, treatment was highly desirable (30 < DAI < 35) and 10.9% showed a severe malocclusion and treatment was considered mandatory (DAI > 35). There were statistically significant differences between the genders for DAI (Chi-square = 10.10, df = 3, p < 0.05) and AC (Chi-square = 17.28, df = 4, p < 0.001) treatment need categories.

Tables IV and V show the cross tabulation of treatment need categories and treatment needs using the DAI and AC. There was a strong positive correlation between the DAI and AC scores (rho = 0.795; N = 728; p = 0.000). The threshold limit for treatment need according to the DAI (DAI > 30) was lower than that of the AC (AC > 7). Table VI shows the distribution of treatment need (DAI > 30) in subjects with different treatment need categories according to the AC.

The Kappa statistic assessment of the diagnostic agreement between the DAI and AC was 0.55 (95% CI: 0.48-0.63), indicating a moderate level of agreement. The observed percentage diagnostic agreement between the DAI and AC was 87.6% (Table V). Using cut-off points suggested by Beglin and colleagues[11] (28 and 5 for the DAI and AC, respectively), the Kappa statistics for diagnostic agreement increased to 0.60 (95% CI: 0.56 - 0.65). However, the observed percentage diagnostic agreement between the DAI and AC decreased to 81.5 per cent.

Discussion

The sample used in the present study was diverse and represented a broad range of malocclusions and treatment needs. This allowed an assessment of the relationship between the DAI and AC scores. According to Hunt and colleagues,[16] indirect support for using a measure of aesthetic impairment to scale or quantify malocclusion has come from the failure of previous longitudinal studies to establish a relationship between malocclusions and dental disease.[17,18] The main harmful effect of malocclusion was considered to be psychosocial in nature and related to aesthetic impairment.[16] This prevalent perception has not been proven by longitudinal studies[19-22] and therefore there are limitations associated with the use of aesthetic indices.[1,23] The DAI lacks measures to assess occlusal traits such as buccal crossbite, centreline discrepancy and deep overbite, which reduce the power of the index.[12,24,25] In addition, the DAI does not account for missing molars.[1] Further, the DAI measurements are made using a millimetre gauge and small errors in accuracy may have an exaggerated effect because of the index weighting. The AC does not measure occlusal traits and its greatest limitation is its subjective nature.[1]

In the present study, the DAI identified a greater proportion of subjects in need of treatment (21.8%) compared with the AC (10.9%) and the threshold limit for treatment need according to the DAI (DAI > 30) was lower than that of the AC (IOTN). Therefore, the 'definite need' under DAI was not equivalent to the 'definite need' under the AC. A possible explanation for this discrepancy may be that occlusal traits such as missing teeth can attract a very high DAI score without representing a high AC score. Theoretically, it is possible to calculate DAI scores of more than 30 in subjects with an AC score lower than 8. Cases exhibiting agenesis of posterior teeth may be scored highly with the DAI, but agenesis can be associated with well-aligned anterior segments which would not attract a high AC score and therefore be placed in the 'no need' category of the AC. Alternatively, cases presenting with a reverse overjet and well-aligned arches may attract a high AC score, but a low DAI score, and consequently, be placed in the 'no treatment need' category of the DAI. The approximately 13%

disagreement between the two indices is therefore, partially explained.

Several studies have objectively compared the two indexes (DAI and AC)[12,13] and a significant level of association has been reported. Otuyemi and Noar[12] and Shue-Te Yeh and colleagues[13] determined correlation coefficients (r) of 0.67 and 0.54, respectively. According to the present findings, the DAI scores were found to have a statistically significant association with AC scores (rho = 0.795). A significant correlation between DAI and AC scores was expected, considering that both indices are heavily based on the aesthetic aspects of occlusion. A lower level of correlation reported previously was perhaps due to little variation in the study samples. Otuyemi and Noar[12] and Shue-Te Yeh and colleagues[13] used small sample sizes of 53 and 50, respectively. Statistically, little variation in the study sample produced poor correlations.[26] An acceptable level of correlation between DAI and AC scores in the present study was interrelated to the diverse ordinal scale of the scores in a diverse sample which represented a broad range of treatment needs.

A study by Manzanera and colleagues[14] used the intra-class correlation coefficients to assess agreement between the DAI (expressed on a four-grade scale) and the AC (on a three-grade scale) and a low level of agreement was reported between the two indices.[14] However, in a clinical setting and vital for resource allocation, importance is placed on the level of diagnostic agreement related to definite treatment need. An observed percentage agreement and Kappa statistics were used to assess the diagnostic agreement between the DAI and AC. These are methods which have been previously used to assess agreement between orthodontic indices.[14,27] The Kappa statistic accounts for observers agreeing or disagreeing simply by chance and provides more information than a simple calculation of the proportion of agreement. [28]

Beglin and colleagues[11] compared three occlusal indices, including the DAI and AC, and recommended using cut-off points of 28 and 5 for the DAI and AC, respectively.[11] Using these cut-off points, the present study calculated the observed percentage agreement and Kappa statistics. Although the Kappa statistics improved, the observed percentage agreement decreased. The possible explanation for the decreased observed percentage agreement may be due to the different distribution of DAI and AC scores in the study sample. The prevalence of the finding under observation (i.e., for rare observations) can affect the Kappa value and produce a limitation of the Kappa evaluation.[28]

The current findings indicated a moderate level of agreement between the DAI and AC, indicating that there may be a difference of nearly 13% between estimates when either index is used to assess treatment need. This difference requires consideration when measuring, recording, or comparing results from different epidemiological studies. The country in which an orthodontist practices often has an effect on the clinician's evaluation of the need for treatment.[29] Therefore, the decision threshold of an index may require adjustment for different national standards before application in a new setting. The differences found in the estimates of orthodontic treatment need for two indices highlights the need for a unified and universal orthodontic index.[30,31] The decision to provide treatment should be based on valid clinical factors, including the severity of malocclusion, the patient's cooperation and cost and risks of treatment, rather than solely on an index.[32]

Conclusion

The DAI and AC (IOTN) showed a strong association. However, according to the previously recommended cut-off points of 30 and 8, only a moderate level of agreement was shown. Based on the current sample, an estimate of orthodontic treatment need can vary in nearly 13% of cases, depending on the index used. This difference highlights the need for a unified and universal orthodontic index and requires consideration when interpreting, comparing or quantifying orthodontic treatment needs. Using new cut-off points of 28 and 5 for the DAI and AC, respectively, improved the Kappa statistics (good level of agreement). However, these cut-off points decreased the observed percentage agreement between two indices.

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