Orthodontic Treatment Need and Demand in Senegalese School Children Aged 12–13 Years

An Appraisal Using IOTN and ICON

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ABSTRACT

Objective: To assess the normative need, knowledge of, and demand for orthodontic treatment in Senegalese schoolchildren aged 12–13 years.

Materials and Methods: The sample consisted of 665 Senegalese schoolchildren randomly selected from different ethnic and socioeconomic backgrounds. The normative orthodontic treatment need was assessed using the Dental Health Component (DHC) and the Aesthetic Component (AC) of the Index of Orthodontic Treatment Need (IOTN) and the Index of Complexity, Outcome, and Need (ICON). Knowledge of and demand for orthodontic treatment were assessed with a questionnaire.

Results: The DHC and the AC of the IOTN and the ICON classified respectively 42.6%, 8.7%, and 44.1% of the children as having a definite need for orthodontic treatment. There were no ethnic or gender differences with respect to normative orthodontic treatment need. The mean ICON score ranged from 42.31 to 44.46 according to the ethnic group. Only 10% of the children had some knowledge of orthodontics. However, between 17% and 30% of the children clearly expressed a need for orthodontic treatment, and the distribution between ethnic groups was significant. In contrast, there were no significant gender differences concerning this demand for treatment.

Conclusions: The present study shows that the need for orthodontic treatment far exceeds the actual available supply.

KEY WORDS: Treatment need; Demand; Index of Orthodontic Treatment Need (IOTN); Index of Complexity, Outcome, and Need (ICON)

INTRODUCTION

The Alma Ata Conference on Primary Health Care in 1978 stated that "health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.[1]" Orthodontic anom-

alies have been associated with psychosocial distress,[2,3] poor periodontal condition,[4] and impaired masticatory function,[5] and so should be regarded as a health problem. For orthodontic treatment to become an integral part of oral health care programs, basic information on treatment needs is required. Recent studies on the prevalence of malocclusion in Africa are scant. Specifically, the last epidemiological survey on malocclusions in Senegal dates back to 1993 and needs updating.[6] Also, the available data were based on qualitative methods, ie, the Angle classification and the World Health Organization (WHO)/Federation Dentaire Internationale (FDI) method, instead of quantitative indices.[6] Issues have been raised related to the validity and reliability of Angle's classification as an epidemiological tool.[7]

Furthermore, the presence of normative needs for orthodontic treatment is not necessarily a decisive factor in seeking orthodontic treatment. A variety of so-

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cial, economic, and cultural factors (esthetic judgment, income, and availability of providers) may influence personal perception of the need for orthodontic treatment.[8]

The main aim of this study was to assess the normative need for orthodontic treatment in Senegalese schoolchildren aged 12–13 years using two occlusal indices. A second aim was to assess knowledge of and demand for orthodontic treatment.

MATERIALS AND METHODS

Study Population

The target population consisted of Senegalese schoolchildren aged 12–13 years. Senegal is a West African country with a total area of 196,190 km[2]. It is divided into 11 administrative regions, each predominantly inhabited by one of five major ethnic groups: Wolofs (43.3%), Pulars (28.3%), Serers (14.7%), Jolas (3.7%), and Mandings (3%). Many other minority ethnic groups, either from neighboring countries (Cape Verde Island, Guinea Bissau, Guinea, Mauritania, and Mali) or from other foreign countries, have lived in Senegal for many generations.

The population of Senegal is estimated at 10,127,809. The mean population density is 51 inhabitants per km[2] with an uneven interregional distribution. Thus, the capital city, Dakar, occupies only 0.3% of the total surface area of the country, and houses 25% of the whole population, with a mean density of 4145 inhabitants per km[2]. The sex ratio is 52% in favor of females.

The average attendance rate of formal education among children aged 12–13 years is 75.8%, with marked interregional disparities.

Sampling Design

The sampling design was based on the WHO guidelines for oral health surveys.[9] According to these guidelines, four sites in the capital city, two sites in each of two large towns, and one site in each of four villages in different regions should be included in the survey. This gives 12 sites to be included; depending on the expected prevalence and the severity of the surveyed condition, the WHO recommends inclusion of 25 to 50 subjects in each site. In all, 300 to 600 subjects should thus be included in such a pathfinder survey.[9]

In a previous study on the prevalence of malocclusion in Senegal, Diagne et al reported that 33% of schoolchildren had some kind of malocclusion.[6] In view of this prevalence rate, the presence of different ethnic groups, their distribution in specific areas, and the uneven density of the population across regions, the WHO guidelines for oral health surveys were adapted to ensure a broad cross-section of socioeconomic and ethnic backgrounds. Thus, the number of sites was raised to 16 and the number of subjects in each site to 40 children.

The schools included in the survey were chosen at random from the list of schools available on the website of the Ministry of Education, which is regularly updated (http://www.education.gouv.sn).

Occlusal Indices Used in This Study

Two occlusal indices were used to assess the need for orthodontic treatment of the target population. These included the Index of Orthodontic Treatment Need (IOTN)[10] and the Index of Complexity, Outcome, and Need (ICON).[11] The IOTN is widely used and has been described extensively elsewhere[10]; therefore, only an outline of the procedures for the rating system of the ICON is presented here.

The ICON was developed for the assessment of orthodontic treatment need, case complexity, and treatment outcome.[11] The ICON weightings are based on the consensus opinion of an international panel of 97 orthodontists from eight European countries (Germany, Greece, Hungary, Italy, the Netherlands, Norway, Spain, and the United Kingdom) and the United States.

All five components are assessed according to the protocol outlined in Table 1. The derived scores are then multiplied by their respective weights and summed. Treatment need for the Dental Health Component (DHC) and the Aesthetic Component (AC) of the IOTN, and for the ICON, was defined according to the categories of scores given in Table 2.

Data Collection

The examination team consisted of the first author (an orthodontist trained and qualified in the use of both IOTN and ICON) and a postgraduate dental student who acted as a recorder. In each site, a member of the school staff randomly chose for examination 40 children aged 12–13 years, with an approximately equal number of girls and boys.

Four types of data were collected using the form shown in the appendix (the original French version was translated).

- Sociodemographic data (age, sex, ethnic group), were obtained directly from the children and their parents and confirmed with the school registers.
- Knowledge of and demand for orthodontic treatment were determined through questions asked by one of the investigators.
- Subjective assessments of orthodontic esthetic at-

TABLE 1. ICON Scoring System[a]

Component		Score					
		0	1	2	3	4	5
1. Aesthetic assessment		Score from 1 to 10 according to the AC of the IOTN					
2. Upper arch crowding/	Crowding	<2 mm	2.1 to 5 mm	5.1 to 9 mm	9.1 to 13 mm	13.1 to 17 mm	>17 mm
spacing	Spacing	<2 mm	2.1 to 5 mm	5.1 to 9 mm	>9 mm		Impacted
3. Crossbite		No crossbite	Crossbite present				
4. Incisors' vertical relation-ship (open bite, over-bite)	Open bite	Edge to edge	<1 mm	1.1 to 2 mm	2.1 to 4 mm	>4 mm	
	Overbite	<1/3 lower in-cisor cover-age	1/3 to 2/3 coverage	2/3 to fully covered	Fully covered		
5. Buccal segment antero-posterior		Cusp to embra-sure only; Class I, II, or III	Any cusp re-lation up to but not in-cluding cusp to cusp	Cusp to cusp			

[a] The ICON has 5 components with a weighting for each: (1) aesthetic component of IOTN (weight = 7), (2) upper arch crowding or spacing (weight = 5), (3) crossbite (weight = 5), (4) overbite or open bite (weight = 4), and (5) buccal segment anteroposterior relationship (weight = 3). ICON indicates Index of Complexity, Outcome, and Need; AC, Aesthetic Component; and IOTN, Index of Orthodontic Treatment Need.

TABLE 2. Cut-Off Points for Allocation of Treatment Need According to IOTN AC, IOTN DHC, and ICON

	No or Slight Need	Moderate Need	Definite Need
IOTN AC	1 to 4	5 to 7	8 to 10
IOTN DHC	1 to 2	3	4 to 5
ICON	<43		≥43

[a] IOTN indicates Index of Orthodontic Treatment Need; AC, Aesthetic Component; DHC, Dental Health Component; and ICON, Index of Complexity, Outcome, and Need.

tractiveness were made by the children and by their parents with the 10 color photographs of the IOTN AC scale. The rating was made separately by the children and their parents. The score obtained corresponds to the degree of esthetic impairment attributable to the malocclusion.

• Normative orthodontic treatment need was assessed using components of both IOTN scales and the ICON. The examinations were made in the knee-to-knee position with disposable gloves, disposable dental mirrors, and disposable IOTN DHC rulers under natural daylight. On average, 20 children were examined daily.

To assess for the reliability of the IOTN and ICON rating, two children were reintroduced blindly for re-examination by the assistant in each session. The assessment with the two indices took about 3 minutes.

Data Analysis

Intraexaminer reliability for the normative orthodontic treatment need was examined with the kappa sta-

tistic, and the interpretation suggested by Landis and Koch[12] was chosen as a reference.

Frequencies and percentages were computed for the nominal variables related to the total sample and between ethnic groups. Chi-square tests were used to test for any dependency on gender and ethnicity of orthodontic treatment need as assessed by IOTN DHC, IOTN AC, and ICON in the whole sample.

Differences in ICON scores between the different ethnic groups were tested using analysis of variance, followed by the Student-Newman-Keuls post hoc test. The t-test was used to test the differences between boys and girls with respect to ICON scores.

Data processing and analysis were carried out using the Statistical Package for Social Sciences (Release 11, 2001, SPSS, Chicago, Ill). For all statistical analyses, the significance level was set at $P = .05$.

RESULTS

Characteristics of the survey population with respect to gender and ethnic group are summarized in Table 3.

Thirty-four subjects were examined twice to assess the examiner's reliability in using both IOTN components and the ICON. The intraexaminer reproducibility for the DHC of the IOTN and for the ICON was almost perfect, with kappa values of .87 and .90, respectively. The reliability of the examiner rating of the AC of the IOTN was substantial, with a kappa value of .66. The distributions of normative orthodontic treatment needs as assessed by the DHC and the AC of the IOTN and by the ICON are given in Table 4.

The DHC of the IOTN classified 42.6% of the chil-

TABLE 3. Descriptive Statistics of the Survey Population

| | | Ethnic Group, Frequency (%) | | | | | | |
		Jolas	Mandings	Pulars	Serers	Wolofs	Others	Total
Gender	Girls	33 (51.6)	38 (51.4)	81 (53.6)	49 (60.5)	111 (45.5)	26 (51.0)	338 (50.8)
	Boys	31 (48.4)	36 (48.6)	70 (46.4)	32 (39.5)	133 (54.5)	245 (49.0)	327 (49.2)
Total		64 (9.62)	74 (11.13)	151 (22.71)	81 (12.18)	244 (36.69)	51 (7.67)	665 (100.0)

TABLE 4. Prevalence of Treatment Needs According to the DHC and AC of the IOTN and to the ICON and Percentage Ranges Among the Different Ethnic Groups. Chi-Square Test Was Performed to Control for Any Difference Between Ethnic Groups

	Prevalence Rate (%)	Percentage Ranges	Chi-Square Test	
AC	No/slight need	69.6	59.3 to 78.4	$P = .19$
	Borderline need	21.7	15.6 to 24.7	$df = 10$
	Definite need	8.7	5.9 to 16.0	$\chi^2 = 13.57$
DHC	No/slight need	23.3	18.5 to 25.5	$P = .37$
	Borderline need	34.1	28.4 to 40.6	$df = 10$
	Definite need	42.6	33.8 to 53.1	$\chi^2 = 10.81$
ICON	No/slight need	55.9	50.0 to 68.6	$P = .31$
	Definite need	44.1	50.0 to 31.4	$df = 5$
				$\chi^2 = 5.86$

[a] DHC indicates Dental Health Component; AC, Aesthetic Component; IOTN, Index of Orthodontic Treatment Need; and ICON, Index of Complexity, Outcome, and Need.
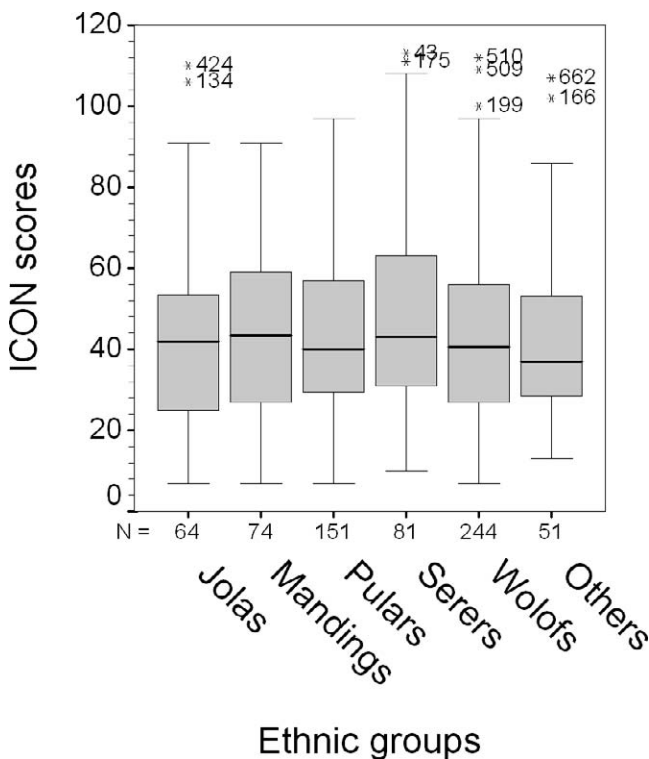
Figure 1. Distribution of the ICON scores among the different ethnic groups. The boxes represent the 75th and 25th percentiles and the bold black lines indicate the mean.

dren as being in definite need of orthodontic treatment. The figures were a little higher when the ICON was used to assess treatment need, with 44.1% of the sample needing treatment. For the AC of the IOTN, only 8.7% of the sample was in definite need of orthodontic treatment. The variability of orthodontic treatment need among the different ethnic groups was not significant. There were also no significant gender differences in treatment need assessed with the DHC, the AC, or the ICON.

The mean ICON scores among the different ethnic groups ranged from 42.31 to 44.46. The differences in ICON scores between different ethnic groups and between boys and girls were not significant (Figure 1).

The distribution of DHC grades and qualifiers of the total sample is shown in Table 5. Contact point displacement was the most commonly found occlusal trait in the sample (49.40%) and placed 18% in the definite-need group. This was followed by dental crossbites, which accounted for 23%.

Significant differences were noted between the children, the parents, and the orthodontist when the AC was used to assess orthodontic treatment need (Table 6). The response rate concerning knowledge of and interest in orthodontic treatment was 100%. Only 10% of the surveyed children had heard about or seen braces, but the distribution varied widely across ethnic groups (Table 7).

Concerning demand, there were significant differ-

TABLE 5. Distribution of DHC Grades and Qualifiers of the Total Sample

Grade	Qualifier	No.	%	Total	%
5	h	0	0.0	26	3.91
	i	23	3.5		
	a	3	0.5		
	m	0	0.0		
	p	0	0.0		
	s	0	0.0		
4	h	26	3.9	257	38.65
	a	33	5.0		
	b	1	0.2		
	m	0	0.0		
	c	44	6.6		
	l	24	3.6		
	d	119	17.9		
	e	5	0.8		
	f	3	0.5		
	t	2	0.3		
	x	0	0.0		
3	a	17	2.6	225	33.83
	b	1	0.2		
	c	51	7.7		
	d	152	22.9		
	e	4	0.6		
	f	0	0.0		
2	a	44	6.6	140	21.05
	b	1	0.2		
	c	34	5.1		
	d	57	8.6		
	e	1	0.2		
	f	3	0.5		
1		17	2.6	17	2.55

[a] DHC indicates Dental Health Component of the Index of Orthodontic Treatment Need; i = impacted tooth; h = missing tooth; a = overjet; m = reverse overjet with reported masticatory or speech difficulties; b = reverse overjet without reported masticatory or speech difficulties; p = defects of cleft lip and palate; s = submerged deciduous tooth; e = openbite; l = posterior crossbite with no functional occlusal contact in one or both buccal segment; c = other crossbites; d = displacement of contact point; e = openbite; f = overbite; t = impacted tooth; x = presence of supernumerary tooth.

ences between the ethnic groups, with the figures ranging from 17% to almost 30% (Table 7). In contrast, there were no significant gender differences concerning the demand for treatment.

DISCUSSION

Normative Assessment of Orthodontic Treatment Need

Our estimates of orthodontic treatment need as assessed by the DHC of the IOTN (42.6%) and by the ICON (44.1%) exceeded those reported in Turkish (38.8%),[13] Irish (30.4%),[14] and Kuwaiti children (28%),[15] but were below those reported in Malaysian schoolchildren (47.9%)[16] and Singaporean adult male recruits (50.1%).[17] However, the treatment need in the latter study was assessed by study cast measure-

ments.[17] In such a case, some malocclusion-related complications such as incompetent lips, functional mandibular shift, and masticatory and speech difficulties were assumed to be present even though they may have been clinically absent.

The available African studies using the IOTN reported a much lower prevalence for Nigerian children (13%)[18] and for Tanzanian children (22%).[19] However, both studies reported on children in a wider age bracket than those in the present study.

To the best of our knowledge, there is only one survey of orthodontic treatment need with ICON, and in that study, involving 505 schoolchildren aged 12–13 years, Liepa et al[20] found 35.3% to be in definite need of orthodontic treatment.

Also, this prevalence rate is higher than that reported by Diagne et al[6] in Senegalese schoolchildren (32.61%), but this could be because of differences in the indices used rather than because of an epidemiological transition. There were no significant differences between the ethnic groups with respect to orthodontic treatment need. The almost-equal mean ICON scores in the different ethnic groups (42.31 to 44.46) (Figure 1) confirm this observation. This was an expected result because the ethnic groups in Senegal are distinguishable only by names and linguistic and cultural features, and not physically.

A close analysis of the distribution of DHC grades and qualifiers in the total sample shows that contact point displacement was the most commonly found occlusal trait (49.40%) in the sample and placed almost 18% in the definite-need group, followed by dental crossbites, which accounted for 23% and indicated definite need for 10.8% of the children. These findings should have public dental health implications because crowding is the occlusal trait most commonly associated with poor periodontal condition and crossbite with gingival recession.[4]

The professional assessment of treatment need with the AC of the IOTN classified only 8.7% of the sample as being in definite need of orthodontic treatment. These figures are comparable to those reported in other African surveys using the IOTN. For instance, Otuyemi et al[18] and Mugonzibwa et al[19] found 7% and 11% of Nigerian and Tanzanian children in definite need of orthodontic treatment on the basis of the AC component. On the other hand, a greater rate of AC grade 8–10 has been reported for other racial groups.[16] The high discrepancy between treatment needs, as indicated by the AC of the IOTN on the one hand and the DHC of the IOTN and the ICON on the other hand, may be because of the fact that malocclusion traits such as missing teeth and crossbites of posterior teeth do not always have an esthetic impact.

The assessment of orthodontic esthetics by parents

TABLE 6. Distribution of Treatment Need of Total Sample and Among Children, Orthodontist, and Parents in Frequencies and Percentages According to the AC of the IOTN

		Frequency (%)			
		Children	Orthodontist	Parents	Chi-Square Test
AC of the IOTN	No/slight need	573 (86.2)	463 (69.6)	540 (81.2)	$P < .001$
	Borderline need	71 (10.7)	144 (21.7)	75 (11.3)	$df = 4$
	Definite need	21 (3.2)	58 (8.7)	19 (2.9)	$\chi^2 = 59.44$

ᵃ AC indicates Aesthetic Component; IOTN, Index of Orthodontic Treatment Need.

TABLE 7. Knowledge of Orthodontic Treatment and Treatment Need Expressed by Children in Frequencies and Percentages Among Ethnic Groups and of Total Sample

		Ethnic Group, Frequency (%)							
		Jolas	Mandings	Pulars	Serers	Wolofs	Others	Total	Chi-Square Test
Knowledge of orthodontic treatment	Yes	0 (0.0)	4 (5.4)	7 (4.6)	4 (4.9)	44 (18.0)	13 (25.5)	72 (10.82)	$P < .001$
	No	64 (100)	70 (94.6)	144 (95.4)	77 (95.1)	200 (82.0)	38 (74.5)	593 (89.18)	$df = 5$
									$\chi^2 = 10.17$
Demand	Yes	11 (17.2)	14 (18.9)	27 (17.9)	24 (29.6)	70 (28.7)	13 (23.5)	12 (23.8)	$P < .001$
	No	53 (82.8)	60 (81.1)	124 (82.1)	57 (70.4)	174 (76.5)	38 (6.4)	545 (76.2)	$df = 5$
									$\chi^2 = 43.40$

placed only 2.9% of the children in AC grade 8–10 (definite need), whereas 3.2% of the children rated their own teeth in this subgroup. This finding that lay-persons are more lenient than professionals with respect to dental esthetics has been reported by other investigators.[21–23]

Knowledge of and Demand for Orthodontic Treatment

The question, "Have you ever seen anyone with braces or heard about a treatment to straighten teeth?" elicited 593 negative responses (89.2%). On the other hand, 158 children (23.8%) needed treatment to straighten their teeth. A close analysis of the results showed that 78.5% of the children who knew nothing about orthodontic treatment nevertheless wanted their teeth to be well-aligned. It appears from this and earlier studies that there is a common perception of orthodontic esthetics. This commonality may be for specific occlusal traits, and cultural and socioeconomical background may influence a subject's judgment.[8] The current low level of knowledge about orthodontic treatment could be due, at least to some extent, to a low exposure to orthodontics for most of the children surveyed. In Senegal, the practice of orthodontics is in its infancy, with only one dental school and no postgraduate program. There are only eight specialized orthodontists practicing, and all are in Dakar, the capital city, which is home to only 25% of the total population.

As in the case of the professional assessment of orthodontic treatment need, there were no gender differences in the subjective perception of treatment need (demand). Conflicting results have long been reported concerning the influence of sex on both normative and perceived need for orthodontic treatment. For instance, Kerosuo et al[24] and Esa et al[25] found higher normative treatment needs for males than for females, but higher needs have been reported for female than for male subjects by Burden et al[26] and Tuominen et al.[27]

On the other hand, significant differences in subjective perception of treatment need were noted between the ethnic groups, with figures ranging from 17% to almost 30% (Table 6). This finding may be because of the fact that the capital city, where all the orthodontists practice, is inhabited mainly by Wolofs. Better availability of health care services has been associated with greater demand.[28]

CONCLUSIONS

- 42.6%, 44.1%, and 8.7% of the sample needed definite orthodontic treatment on the basis of the DHC, ICON, and AC, respectively.
- Of the surveyed children, 10.8% had some knowledge about orthodontic treatment, whereas 23.8% needed treatment to straighten their teeth.
- The need for orthodontic treatment far exceeds the actual available supply.

ACKNOWLEDGMENT

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A P P E N D I X

ASSESSMENT FORM

Socio demographic data

        Subject N°   …………

        Date of birth   ………

        Sex[1]   :   Male   Female

        Ethnic group: ………………………

        Site: ………………………

        Parents' occupation: ………………………

Knowledge about orthodontics

        Have you ever seen someone with braces or heard about a treatment to straighten teeth[1]?

                Yes   No

        Do you feel your teeth need such a treatment[1]?

                Yes   No   don't know

        Have you ever received such treatment[1]?

                Yes   No

Child's assessment of orthodontic aesthetic attractiveness

Here is a scale of 10 photographs of teeth showing different levels of attractiveness. Photo N° 1 is considered the most attractive and photo N° 10 the least attractive. Where would you put your teeth on this scale?

Aesthetic Component (AC) score   ……………………

Parent's assessment of orthodontic aesthetic attractiveness

Here is a scale of 10 photographs of teeth showing different levels of attractiveness. Photo N° 1 is considered the most attractive and photo N° 10 the least attractive. Where would you put your child's teeth on this scale?

Aesthetic Component (AC) score   ……………………

Normative assessment of orthodontic treatment need

Index of Orthodontic Treatment Need (IOTN)

Aesthetic Component (AC) score   ……………………

ANOMALIES													
Missing teeth		Overjet/ Reverse		Crossbites			Displacement of contact points	Over/Openbite		Others				
i	h	a	m	b	c	l	d	f	e	p	s	t	x	g

Dental Health Component (DHC) score   ……………………

Index of Complexity Outcome and Need (ICON)

Components	Upper arch crowding/spacing		Crossbite	Incisors vertical relationship (Openbite, overbite)		Buccal Segments Antero-posterior relationships	Aesthetic component IOTN
	Crowding	Spacing		Openbite	Overbite		
Score							
Weighting	5	5	5	4	4	3	7
Total							

ICON score   ……………………

[1] Circle the correct answer