

Assessment of Malocclusion Severity Levels and Orthodontic Treatment Needs using the Dental Aesthetic Index (DAI): A Retrospective Study

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ABSTRACT

Introduction: Dental malocclusion is the 3rd most common dental health problem. Several indexes are used for malocclusion registration to evaluate the severity levels and orthodontic treatment needs. The Dental Aesthetic Index (DAI) is an orthodontic index based on socially defined aesthetic standards. It is useful in both epidemiological surveys to identify unmet need for orthodontic treatment and as a screening device to determine priority for subsidized orthodontic treatment.

Objectives: To retrospectively determine the severity levels and orthodontic treatment needs, and prevalence of different malocclusion traits of the patients treated at King Faisal Hospital Kigali, Rwanda.

Methods: 170 pairs of pre-treatment orthodontic study models of patients in the age group of 11 – 35 years of both genders were studied in the Dental department of King Faisal Hospital Kigali, Rwanda, collected during the period of October 2008 to May 2013. Dental Aesthetic Index (DAI) devised by Cons et al in 1986, and adopted by WHO for epidemiological studies as a cross cultural index, was used to assess each pair and a cumulative score was calculated as per the standard DAI method.

Results: Only 11% of the sample had no need of treatment, while remaining 89% needed some kind of orthodontic treatment with variable levels of severity. Out of them, 23% had severe malocclusion and 51% had handicapping malocclusion. 64% presented with normal molar relationship. Incisal crowding and increased overjet were the most frequently observed problems. Anterior open bite and midline diastema showed high prevalence rates.

Conclusion: Most of the patients who had received orthodontic treatment at King Faisal Hospital were really in need of the treatment. DAI can be used as a screening method for assessing the severity of malocclusion and thus to prioritize the need of orthodontic treatment especially in publically-funded institutions.

Keywords: - Dental Aesthetic Index - Prevalence - Treatment needs.

RESUME

Introduction : malocclusion dentaire est le 3ème problème de santé dentaire le plus commun. Plusieurs index sont utilisés pour l'enregistrement malocclusion pour évaluer les niveaux de sévérité et les besoins de traitement orthodontiques. L'Index Esthétique Dentaire (DAI) est un index orthodontique basé sur les normes esthétiques en société définies. C'est utile tant dans les enquêtes épidémiologiques d'identifier le besoin non rencontré pour le traitement orthodontique que dans comme un artifice de projection de déterminer la priorité pour le traitement orthodontique conventionné.

Objectifs : rétrospectivement déterminer les niveaux de sévérité et les besoins de traitement orthodontiques et la prédominance de différents traits malocclusion des patients a traité à l'Hôpital de Roi Faisal Kigali, le Rwanda.

Méthodes : 170 paires de pré-traitement les modèles d'étude orthodontiques de patients dans la tranche d'âge de 11 – 35 ans des deux genres ont été étudiées dans le département Dentaire d'Hôpital de Roi Faisal Kigali, le Rwanda, recueilli pendant la période d'octobre de 2008 jusqu'au mai de 2013. L'Index Esthétique Dentaire (DAI) conçu par Trompe et al en 1986 et adopté par que pour les études épidémiologiques comme un index culturel fâché, a été utilisé pour évaluer chaque paire et un score cumulatif a été calculé selon la méthode de DAI standard.

Résultats : Seulement 11 % de l'échantillon n'avait aucun besoin de traitement, pendant que la conservation de 89 % a eu besoin de quelque traitement orthodontique avec les niveaux variables de sévérité. D'eux, 23 % avaient malocclusion sévère et 51 % avaient malocclusion handicapant. 64 % présentés avec le rapport de molaire normal. Incisal le surjet s'entassant et augmenté étaient les problèmes le plus souvent observés. Le morceau ouvert antérieur et midline diastema ont montré de hauts taux de prédominance.

Conclusion : la Plupart des patients qui avaient reçu le traitement orthodontique à l'Hôpital de Roi Faisal étaient vraiment dans le besoin du traitement. DAI peut être utilisé comme une méthode de projection pour évaluer la sévérité de malocclusion et ainsi à priorizer le besoin de traitement orthodontique surtout dans les institutions publiquement financées.

Mots clés: Malocclusion - Index Esthétique Dentaire – Prédominance - Besoins de traitement

INTRODUCTION

Any deviation from the normal arrangement of teeth is referred to as malocclusion. Malocclusion is a disorder of multiple traits which may be present singly or in combinations. Patients visiting the dental clinics chiefly complain of the irregular arrangement of teeth, presence of spaces between teeth, teeth are placed outward / forward, teeth not closing properly, teeth not erupting in line etc. Some patients also complain of problems during smiling, talking, biting the food, and teasing by peers. Thus, malocclusion not only affects the smile, aesthetics

and function, but also the social and psychological status of the patient. Because of the increasing importance of esthetic considerations and dental appearance, the people are strongly motivated to seek orthodontic treatment. Major benefits of orthodontic treatment are improvement in physical function, prevention of tissue damage, improved aesthetics and psychosocial well-being [1, 2].

Malocclusion is undoubtedly a public health concern in any country. Dental public health administrators and epidemiologists need an epidemiological tool to rank dental esthetics and orthodontic treatment needs on a scale of social norms for a socially acceptable dental appearance [3]. Richmond et al [4] defined occlusal indices as methods for determining the amount of deviation from normal occlusion; the level of treatment need; and for

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the evaluation of individual patients and populations. Orthodontic need and demand assessment is of interest for dental public health programs, screening for treatment priority, resource planning and third party funding.

Many occlusal indices have been proposed to categorize the malocclusion according to severity and need of treatment. Dental Aesthetic Index (DAI) was introduced by Cons et al in 1986 [5] which links objective, clinical, and subjective esthetic factors to produce a single score that reflects severity and the treatment needs of the malocclusion [5, 6]. It involves those traits which lead to esthetic and social problems to patients and are among the common complaints with which the patients come for treatment. It has been used in many studies to determine orthodontic treatment needs in different countries [6, 7]. It also allows orthodontic public health officers or insurance programs to screen and identify the patients eligible for receiving subsidized, publically – funded orthodontic treatment and thus allows better use of limited available resources [6].

Since its development, it has proven to be reliable and valid as well as a simple and easily applied index. It has been adopted by the World Health Organization (WHO) as a cross-cultural index [8] and has been applied among diverse ethnic groups without any modification [9–14]. It evaluates 10 occlusal characteristics and the final DAI scores are categorized in 4 levels of malocclusion severity: a score lower than or equal to 25 (no or slight treatment need), a score between 26 and 30 (elective treatment), a score between 31 and 35 (treatment highly desirable) and a score greater than 36 (treatment mandatory) [5]. (Table 1 a, b)

Table 1a: (DAI SCORE CARD)

| | | A | B | C |
|----|--|-----|-----|----|
| | | NO. | WT. | |
| 0 | CONSTANT | | | 13 |
| 1 | Missing incisors, canine, premolar teeth – upper and lower, (enter total no.) | | 6 | |
| 2 | Crowding in the anterior segment | | 1 | |
| | <ul style="list-style-type: none"> • 0- no segment crowded; • 1- one segment crowded; • 2-two segments crowded; | | | |
| 3 | Spacing in the incisal segment | | 1 | |
| | <ul style="list-style-type: none"> • 0- no spacing; • 1- one segment spacing; • 2-two segments spacing; | | | |
| 4 | Midline diastema in mm | | 3 | |
| 5 | Largest anterior irregularity in maxilla (mm); | | 1 | |
| 6 | Largest anterior irregularity in mandible (mm); | | 1 | |
| 7 | Anterior maxillary overjet (mm); | | 2 | |
| 8 | Anterior mandibular overjet (mm) | | 4 | |
| 9 | Anterior open bite (mm) | | 4 | |
| 10 | Antero posterior molar relation: 0- normal; 1- ½ cusp; 2- On full cusp; | | 3 | |
| 11 | TOTAL DAI SCORE | | | |

Table 1b: Classification according to DAI score:

| DAI Scores | Treatment Category | Severity Levels |
|------------|----------------------------------|---|
| <25 | No treatment need or slight need | Normal or minor malocclusion |
| 26–30 | Treatment elective | Definite malocclusion |
| 31–35 | Treatment highly desirable | Severe malocclusion |
| >36 | Treatment mandatory | Very severe (handicapping) malocclusion |

In Rwanda, the orthodontic treatment is sponsored by Rwanda Social Security Board (RSSB) and Military Medical Insurance (MMI) insurances for their partners, which are State agencies, but it is for the correction of only functional disturbances caused by dental malocclusion, and not for esthetic purpose. The private insurance companies do not sponsor orthodontic treatment to its customers. High – income families who are not partners with insurances bear the cost of treatment themselves, being affordable to them. The insurance providers must be aware of the tool to judge the severity levels of malocclusion and need of orthodontic treatment, so that people do not take undue advantage of the facility to get the treatment only for esthetic purpose. It helps to prioritize the services. Prioritization of orthodontic services would assist to ensure that these services are preferentially provided to those patients most likely to derive the greatest benefit. The Dental Aesthetic Index (DAI) is used to estimate orthodontic treatment need and can also be used as a screening tool to determine treatment priority [6, 7]. However, it focuses on aesthetics and therefore omits other malocclusion traits thereby limiting its comprehensiveness as an assessment tool [15].

Review of literature

Many studies have used DAI to evaluate orthodontic treatment needs based on severity of malocclusion. It has been used both as an epidemiological tool on the populations in some studies [9-14, 16-19] and by evaluation of pre-treatment orthodontic study models in other studies [7, 15, 20-23].

Jenny and Cons in 1996 assessed 1306 pre-treatment study models of patients aged 12–17 years found that 45.8 per cent of the sample was having normal or minor malocclusion and had no need or slight need for treatment [7]. Maumela, Patricia, and Mutsinda in 2010 in a study on 120 pre-treatment study models of patients aged 10-45 years found that 19.1% had normal or minor malocclusion, while 80 % needed some kind of orthodontic treatment. Out of them, 17.5% had definitive malocclusion, 21.7% had severe malocclusion and 41.7% had handicapping

malocclusion. The mean DAI score was 35.2 ± 10.3 . The study also identified many other malocclusion traits: crowded and rotated posterior teeth (27.5%), posterior cross bite (22.8%), retained primary teeth (13.4%), missing molars (10.7%), partially erupted teeth (9.4%), deep overbite (8.1%), transposition (3.4%), peg lateral (3.4%) and supernumerary teeth (1.3%). These traits are not considered by DAI, but strongly affect the treatment needs of the patients, which is a drawback of DAI index [15].

Onyeaso and BeGole [20] studied 100 pre-treatment study casts of 10 – 52 years old patients, to assess the objective orthodontic treatment needs of patients treated in an accredited orthodontic clinic in North America using a retrospective cross sectional study and DAI. 85% of the study sample needed orthodontic treatment with different malocclusion severity levels, while 47% of the cases qualified for publicly subsidized treatment due to handicapping malocclusions. Thus DAI can be helpful to prioritize the treatment and select the patients who are most in need of treatment.

Hlongwa, Beane, Seedat, and Owen in 2004 [21] conducted a study on 120 pre-treatment study models selected from orthodontic patient records treated at Department of Orthodontics, University of North Carolina, U.S.A. The sample consisted of 60 African-Americans (Black) and 60 American Caucasians (White), in the age range of 12 - 16 years. They concluded that DAI could be used consistently to identify orthodontic treatment needs in different ethnic groups and capable of classifying the subjects according to their malocclusion severity for those subjects eligible for treatment in fund - constrained situation.

Onyeaso in 2004 [22] studied 136 participants (67 males, 69 females) of 6 - 18 years of age who had reported to seek orthodontic treatment and found that 30 per cent participants presenting for orthodontic treatment had actually 'no/little' need of orthodontic treatment. Out of the "in – need – of – treatment" participants, the 20% had DAI scores between 26 and 30 indicating that treatment was 'elective', 15% had a 'desirable' need for treatment, and 35% had a 'mandatory' need for treatment. This study showed that not all outpatients presenting/referred for orthodontic treatment 'need' the treatment, and therefore proper screening of the patients should be done if the treatment is to be publicly – funded.

Poonacha, Deshpande, and Shigli (2010) assessed 100 pre-treatment dental casts of 12 – 14 years old Indian patients found that only 3% patients were in no or slight need of treatment category, while 97 % needed orthodontic treatment. Since in India, this treatment is not funded or insured, the patients who go to clinics to receive this treatment pay themselves and are thus actually in the need of treatment, which can be seen by only 3 % patients in the "no – need – of – treatment" category [23].

Since there was no study available in literature assessing the orthodontic treatment needs in the Rwandese population, therefore this retrospective, descriptive, cross-sectional study was done to evaluate malocclusion severity levels and the associated objective orthodontic treatment needs using the DAI and pre- treatment orthodontic study models from the records available in Dental department of King Faisal Hospital, Kigali.

AIMS AND OBJECTIVES

This retrospective study was done to evaluate the distribution and assessment of malocclusion severity levels and orthodontic treatment needs using the dental aesthetic index (DAI) to know whether the patients who reported for orthodontic treatment had real orthodontic problems or not.

Specific Objectives:

1. To assess the severity levels of malocclusion.
2. To assess the objective orthodontic treatment needs.
3. To assess the distribution of different malocclusion traits.

Purpose of the study:

In Rwanda, like in other developing countries, due to limited resources, health policies concentrate less attention on dental diseases generally, and on malocclusion disorder specifically. Most of the budget is targeted at infectious diseases due to associated morbidity and mortality with such diseases. Therefore, the patients needing publically – funded orthodontic treatment need to be screened properly for proper utilization of funds. DAI has been proved in previous studies as a reliable and valid index to screen patients to determine actual objective orthodontic treatment needs. In Rwanda, there is no such study on patients - screening suffering from malocclusion. This retrospective study will give us an idea whether the patients undergoing treatment were actually in need of treatment or not.

METHODS

Study design: The study was designed as a retrospective, descriptive, cross-sectional study.

Sample: The study involved assessment of a sample of 170 pairs of pre-treatment orthodontic dental study models selected randomly from a pool of 236 pairs in the Orthodontic Unit of Dental department at King Faisal Hospital, Kigali, Rwanda, collected during the period of October 2008 and May 2013. The casts were of 82 male and 88 female patients, in the age range of 11 – 35 years, who had received or were undergoing orthodontic treatment in the department.

Selection criteria: The age of the patients whose models were included in this study ranged from 11 to 35 years. Models with permanent dentition only were evaluated. Only the pretreatment study models were assessed. Study models of poor quality i.e. with fractured teeth in the study models, models of patients with previous orthodontic treatment, and models with primary teeth were not included.

Method: Each pair of study model was assigned a serial number, which helped to feed the data on a master chart, and then in Epi Info 3.4.3 (2007) version. The DAI was used to evaluate each pair of study casts. It consists of 10 occlusal traits related to dentofacial anomalies assessing the missing teeth, spacing, crowding and occlusion [5, 6]. The components used in DAI are the most common

malocclusion traits for which the patients complain of and come for orthodontic treatment. Scores for each component were multiplied by previously reported weights and a constant was added to obtain a final DAI score for each pair of study models and the findings were recorded in a predetermined form (Table 1 a, b) to evaluate the total score according to DAI method. Twenty study models were examined twice, after 2 weeks by the same orthodontist to calculate the intra-examiner reliability. The attained reliability (Kappa value, 0.85, intra-class correlation coefficient) was in agreement with the recommended standards [8].

Statistical analysis: All statistical analyses were performed using the Epi Info 3.4.3 version, (2007) (Centers for Disease Control and Prevention, Atlanta, GA, USA). The data was evaluated for descriptive statistics for its qualitative and quantitative variables, and the absolute numbers and percent frequencies were obtained. Means and SD were calculated for DAI score and other quantitative variables, for males, females and total sample. The statistical analysis included the comparison of the DAI scores according to sex through the Mann-Whitney / Wilcoxon 2 – sample test and Kruskal-Wallis test for 2 groups at $p < 0.05$. Finally, each DAI component was compared according to sex, using the chi-square test for the qualitative DAI components and the Bartlett’s chi square test, Mann-Whitney or Kruskal-Wallis test for the quantitative DAI components, as appropriate. A value of $p < 0.05$ was considered as the significant level.

RESULTS

The results are shown in Tables 2 – 4. The study sample consisted of 170 pre-treatment orthodontic study models in which 48% belonged to male patients and 52% to female patients. 11% patients were not in the need of any orthodontic treatment, while 89% patients were in need of treatment. Out of them, 51% patients had handicapping malocclusion, (Figures 1,2). The DAI scores ranged from 17 – 74, with mean DAI score for total sample was 37. The mean DAI scores for males and females were 36.64 and 37.46 respectively. The distribution of 10 individual DAI components is shown in Table 4. Dental crowding was the most common malocclusion sign (81%). Almost 27% patients were having midline diastema, 75% with increased overjet (> 3 mm); 15% with anterior cross bite and 14% with open bite. Normal molar relation (Angle’s class I) was present in 64% patients, while 36% had not-normal molar relation. Comparative analysis of each qualitative and quantitative DAI component did not reveal any significant differences between the genders, except mandibular overjet and anterior open bite traits.

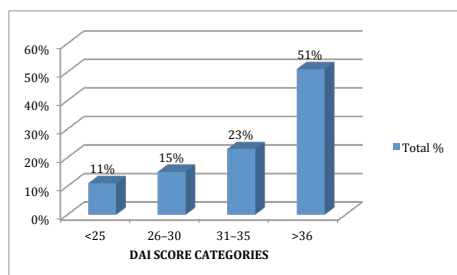


Figure 1: the sample distribution according to DAI scores

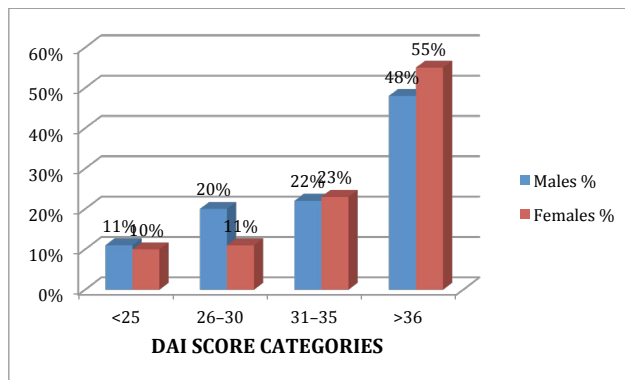


Figure 2: the gender distribution according to DAI scores

DISCUSSION

A large number of adolescents and young adults should receive orthodontic treatment because of the associated health risks, esthetics, functional and psycho-social problems with malocclusion, but unfortunately, not many of them have access to such services [18]. This is probably because of certain reasons, e.g. lack of specialist - orthodontists, lack of resources, high cost and lack of materials and equipments. Also, the orthodontic concern is given a low priority in oral health care system. Although there is a public health system, the lack of resources makes the funds available for dentistry scarce. Hence, orthodontic services are not readily available/accessible to the general population, and being expensive, not affordable to uninsured patients.

Table 2: Distribution of sample according to DAI scores

| DAI Scores | Treatment Category | Severity Levels | Males, n | Males % | Females n | Females % | Total | Total % |
|------------|----------------------------------|---|----------|---------|-----------|-----------|-------|---------|
| <25 | No treatment need or slight need | Normal minor malocclusion | 9 | 11% | 9 | 10% | 18 | 11% |
| 26-30 | Treatment elective | Definite malocclusion | 16 | 20% | 10 | 11% | 26 | 15% |
| 31-35 | Treatment highly desirable | Severe malocclusion | 18 | 22% | 21 | 23% | 39 | 23% |
| >36 | Treatment mandatory | Very severe (handicapping) malocclusion | 39 | 48% | 48 | 55% | 87 | 51% |
| Total | | | 82 | 100% | 88 | 100% | 170 | 100% |

(Chi square 2.3376, df = 3, $p = 0.5054$, NS); (Frequency distributions % has been rounded off to the nearest number.)

The DAI was selected for this study because it combines dentition, space and occlusion components in the dental arches, representing the objective (occlusal) and the subjective (esthetic) aspects of occlusion [5, 10]. It is a cross-cultural index endorsed by the WHO [8], is relatively simple to use, has high reliability & validity, and therefore is a widely used index. Several studies have suggested

that it can be universally applied without the need for modifications or adaptations to different ethnic or cultural

Table 3: means & range of different DAI parameters among genders and pooled sample

| DAI components | Males | | Females | | Total | |
|---------------------------------------|------------------|---------|------------------|---------|-----------------|---------|
| | Mean \pm SD | Range | Mean \pm SD | Range | Mean \pm SD | Range |
| DAI score | 36.64 \pm 10.3 | 18 – 59 | 37.46 \pm 9.86 | 17 – 74 | 37 \pm 9.58 | 17 – 74 |
| Midline diastema (mm) | 0.47 \pm 0.86 | 0 – 4 | 0.56 \pm 1.32 | 0 – 6 | 0.52 \pm 1.12 | 0 – 5 |
| Anterior maxillary irregularity (mm) | 2.19 \pm 1.76 | 0 – 5 | 2.12 \pm 1.54 | 0 – 5 | 2.15 \pm 1.65 | 0 – 5 |
| Anterior mandibular irregularity (mm) | 1.95 \pm 1.81 | 0 – 6 | 1.59 \pm 1.59 | 0 – 5 | 1.76 \pm 1.71 | 0 – 6 |
| Maxillary overjet (mm) | 6 \pm 3.28 | 0 – 16 | 5.5 \pm 3.13 | 0 – 13 | 5.75 \pm 3.2 | 0 – 16 |
| Mandibular overjet (mm) | 0.15 \pm 0.56 | 0 – 4 | 0.32 \pm 0.76 | 0 – 5 | 0.24 \pm 0.68 | 0 – 5 |
| Open bite (mm) ** | 0.2 \pm 0.75 | 0 – 5 | 0.47 \pm 1.29 | 0 – 8 | 0.34 \pm 1.07 | 0 – 8 |

(** Highly significant, Bartlett's chi square = 23.52, df = 1, p = 0.0000)

settings [9-12]. It has been reported to assess orthodontic treatment need both in developed and developing countries [6].

The DAI scores for our sample ranged from 17 – 74, with mean DAI score of 37. It shows that the majority of the patients was having handicapping malocclusion and was in the category of mandatory treatment group (Table 3). When the DAI scores were compared among the genders, no statistically significant differences were found as evaluated by Mann-Whitney / Wilcoxon 2 – sample test and Kruskal-Wallis tests for 2 groups, (equivalent to Chi square) at p-value < 0.05.

On dichotomizing the DAI scores, as "no need for treatment" (DAI \leq 25) and "in need of treatment" (DAI > 25), only 11 % patients were having normal / minor malocclusion and thus in the category of no / slight need of treatment, while remaining 89 % needed orthodontic treatment (Table 2). Jenny and Cons in 1996 [7] found that almost 54 per cent of their sample had need for treatment, while Onyeaso and BeGole [20] reported 85 %, and Poonacha et al [23] reported 97 % of the sample needing the orthodontic treatment. No statistical significant difference could be found between genders in our study (Chi sq 2.3376, df = 3, p = 0.5054).

Different cutoff points (threshold decision to treat) on the DAI score have been proposed to prioritize orthodontic care needs. Initially, Jenny et al [3] suggested a 36 cutoff point to predict handicapping malocclusion. However, later on, the same authors proposed a 31 cutoff point to determine the number of individuals who require treatment [6]. By dichotomizing the present study

sample according to the cutoff point recommended by Cons et al (DAI score \geq 31) [6], then 23% had severe malocclusion and highly – desirable treatment need, and 51% had handicapping malocclusion with mandatory need of treatment (Table 2).

An analysis of the DAI components sheds some light on which malocclusion traits are more commonly present (Table 4). Only few studies [12,16,18,19] have reported analysis by individual DAI components as shown in Table 5. The difference in the prevalence rates of many DAI components in different populations can be due to racial and genetic differences, and other local climatic and other associated risk factors.

The number of missing permanent incisor, canine and premolar teeth in the upper and lower arches was recorded. Teeth were not recorded as missing if spaces

Table 4: Percentage distribution of different DAI components:

| DAI components | Grading | Males | Males % | Females | Females % | Total | Total % |
|---------------------------------------|--------------|--------|---------|---------|-----------|--------|---------|
| | | N = 82 | % | N = 88 | % | N =170 | % |
| Missing teeth | \geq 1 | 8 | 10 % | 15 | 17 % | 23 | 14 % |
| Crowding (incisal segment) | 0 | 16 | 19 % | 16 | 18 % | 32 | 19 % |
| | 1 | 19 | 23% | 25 | 28 % | 44 | 26 % |
| | 2 | 47 | 57 % | 47 | 53 % | 94 | 55 % |
| Spacing (incisal segment) | 0 | 48 | 58 % | 47 | 53 % | 95 | 56 % |
| | 1 | 29 | 35% | 33 | 38 % | 62 | 37 % |
| | 2 | 5 | 6 % | 8 | 9 % | 13 | 8 % |
| Midline diastema (mm) | \geq 1 mm | 25 | 30 % | 20 | 23 % | 45 | 27% |
| Anterior maxillary irregularity (mm) | 0 | 23 | 28 % | 20 | 23 % | 43 | 25 % |
| | 1 – 2 mm | 27 | 33 % | 30 | 34 % | 57 | 34 % |
| | \geq 3 mm | 32 | 39 % | 38 | 43 % | 70 | 41 % |
| Anterior mandibular irregularity (mm) | 0 | 28 | 34 % | 36 | 41 % | 64 | 38% |
| | 1 – 2 mm | 24 | 29 % | 26 | 35 % | 50 | 29 % |
| | \geq 3 mm | 30 | 37 % | 26 | 39 % | 56 | 33 % |
| Maxillary overjet (mm) | 0 – 3 mm | 18 | 22 % | 25 | 28 % | 43 | 25 % |
| | 4 – 7 mm | 34 | 41 % | 40 | 45 % | 74 | 44 % |
| | 8 – 10 mm | 23 | 28 % | 18 | 21 % | 41 | 24 % |
| | \geq 11 mm | 7 | 8 % | 5 | 6 % | 12 | 7 % |
| Mandibular overjet (mm) ** | > 0 mm | 7 | 9% | 18 | 21 % | 24 | 15 % |
| | >0 mm | 8 | 10 % | 15 | 17 % | 23 | 14 % |
| | Normal | 52 | 63 % | 56 | 64 % | 108 | 64 % |
| Molar relations | ½ cusp | 8 | 10 % | 11 | 13 % | 19 | 11 % |
| | Full cusp | 22 | 27 % | 21 | 24 % | 43 | 25 % |

were closed, if a primary tooth was still in position and its successor had not yet erupted, or if a missing incisor, canine, or premolar tooth had been replaced by a fixed (**, Significant, chi sq = 4.8066, df = 1, p = 0.0283) (Frequency distributions % has been rounded off to the nearest number.)

prosthesis [8]. In our study, almost 14 % of the study sample had one or more missing anterior teeth either in the maxilla or in the mandible.

Crowding of the incisal segment is a condition in which the available space between the right and left canine teeth is insufficient to accommodate all four incisors in normal alignment; as a result, the teeth may be rotated or displaced out of the arch [8]. Dental crowding in at

least one dental arch in our study was in 81 % of the sample. Incisal segment spacing is a condition in which the amount of space available between the right and left canine teeth exceeds that required to accommodate all four incisors in normal alignment [8]. The frequency of incisal spacing (> 1 mm) was 45 % in at least one of the dental arches. Jenny et al [3] have suggested that inheritance differences in tooth size and arch size in different races may be a reason for differences in DAI scores because the DAI includes measurements of the most relevant orthodontic traits that affect dental esthetics, such as crowding.

Midline diastema is defined as the space, in millimeters, between the two permanent maxillary incisors at the normal position of the contact points [8]. A high percentage of maxillary diastema was found in 27 % of our sample. It shows that African population has more prevalence of maxillary diastema showing racial differences, as also shown in other previous publications [12,18,19,26,27]. Multiple etiological risk factors [26] are associated with the midline diastema, e.g. low – attachment of thick fibrous maxillary labial frenum; large jaw size, small tooth size, parafunctional oral habits, etc. & this aspect needs to be explored in future studies.

Maxillary and mandibular anterior irregularity may be either rotations or displacements from normal alignment. Incisors in both the dental arches should be examined for identification of the greatest irregularity. Irregularities may occur with or without crowding [8]. The frequency of maxillary anterior irregularity greater than 1 mm was in 75 % of our sample, while 62 % in mandibular anterior segment.

Anterior maxillary overjet is a measurement of the horizontal relationship of the upper and lower incisors with the teeth in centric occlusion. The distance from the labial-incisal edge of the most prominent upper incisor to the labial surface of the corresponding lower incisor was measured [8]. Almost 74% patients of Rwanda had overjet > 3mm, where more than 7 mm of overjet was in 31 % of the sample. It shows that Rwandese patients in need of orthodontic treatment have a more prominent maxillary dento-alveolar segment, which can be due to racial differences or the climate of Rwanda which leads to more frequent nasal allergies in children and mouth breathing habit, but this area needs to be explored in future studies to look into the causes of increased overjet in Rwanda population.

Anterior mandibular overjet was recorded when any lower incisor protruded anteriorly or labially to the opposing upper incisor, i.e., is in cross bite. Mandibular overjet was not recorded if a lower incisor was rotated so that one part of the incisal edge was in cross bite (i.e., labial to the upper incisor) [8]. A higher frequency (15 %) of mandibular overjet or anterior cross bite was seen in Rwandese population in the present study, and the frequency distribution was found to have significant statistical difference among the genders (Table 4).

Anterior open bite is a lack of vertical overlap between any of the opposing pairs of incisors (open bite). This condition reflects discrepancies in the vertical plane of space [8]. A higher frequency of anterior open bite was seen in Rwandese population (14%). The mean values of anterior open bite in males and females were statistically

different as evaluated by Bartlett chi square test, ($\chi^2 = 23.52$, $df = 1$, $p = 0.0000$), (Table 3) in our study, with females having higher mean values. Previous reports have also shown that Blacks have a higher prevalence rates of anterior open bite which is attributed to racial variations [27,28].

The antero-posterior molar relationship is based on the relationship between the permanent upper and lower first molars. The right and the left sides were assessed with the teeth in occlusion and only the largest deviation from the normal relationship (Angle Class I) was recorded [8]. Prevalence of abnormal molar relations (other than Class I) was found in only 36 % of Rwandese sample.

Limitations of DAI: With the DAI, the WHO attempted to create an easy index, universally accepted and that could be used in epidemiologic research to establish the orthodontic treatment need and the priority of orthodontic care in public programs. This index has the characteristic of being measurable, objective, simple and easy to use, reliable, valid and requires less professional knowledge of occlusal traits than other indexes. For all these reasons, the DAI may be considered as an appropriate orthodontic treatment need index for conducting epidemiological studies in developing countries [25].

But, there are many malocclusion traits which are not considered by DAI but provide a strong indication of treatment need and change the subjective perceptions for treatment, since orthodontic treatment is not just for esthetics but to improve functions also. During our study, it was observed that DAI underestimates the needs of orthodontic treatment. Some patients who were having certain malocclusion traits leading to esthetic and functional impairment, but not considered by DAI, and had strong subjective & clinical need of treatment were categorized in "no-need or elective - need" categories.

DAI considers crowding in incisal region only, while crowding in the canine – premolar region also is a major cause of esthetic problem often complained by the patients, especially when the patient smiles or laughs. Buccal cross bite, crowding in premolar region, labially / palatally erupted canines and premolars, midline discrepancy, deep and traumatic bite, supernumerary teeth, over-retained deciduous teeth, extracted posterior teeth with disturbed occlusion, mixed dentition period, posterior open bite, parafunctional habits, large tongue size, rotations, skeletal jaw base size, etc. also affect the need of orthodontic treatment, and some may lead to functional and psychological problems. Eg if buccal cross bite leading to functional deviations is present, then it can lead to TMJ problems later on.

Hatzopoulos (1999) also pointed that DAI Index is unable to assess the total occlusal characteristics, the condition of the dental, osseous and soft tissues, and the function of stomatognathic system [24]. It focuses only on aesthetics and therefore omits other malocclusion traits thereby limiting its comprehensiveness as an assessment tool [15]. Another limiting factor is that it was developed for the permanent dentition, and thus is inadequate for assessing the deciduous and mixed dentition and thus unable to identify malocclusion cases in its early stages, which hampers the prevention and early treatment planning.

Despite these factors, the other malocclusion traits have been subjected to additional studies with their own classification criteria over time [25]. It may be

recommended that DAI could also receive modifications in future to overcome its limitations.

CONCLUSION

Most of the patients who had taken orthodontic treatment in Dental Department of King Faisal Hospital, Rwanda, were in great need of treatment, with almost 50% having handicapping malocclusion. The malocclusion was characterized by a high frequency of crowding, increased overjet, midline diastema, open bite and anterior cross bite in this study.

DAI can help as a screening tool to assess the severity level and orthodontic treatment needs. However, the treatment indications by DAI should serve only as a guide since many other traits also influence the decision of orthodontic treatment. The decision cut-off points used to determine the treatment indications can be modified according to local conditions and available resources. Since this was not a prevalence study, it is difficult to directly compare our findings with other population – based studies. However, this study gives us baseline information about the severity levels of the malocclusion disorder. Further population – based studies should be done with using universal criteria so that comparison with other studies is simplified. Also, the future studies should look into the associated risk factors leading to high prevalence of certain malocclusion traits in Rwandese population.

REFERENCES

- Espeland LV, Stenvik A. Perception of personal dental appearance in young adults: relationship between occlusion, awareness, and satisfaction. *Am J Orthod Dentofac. Orthop.* 1991;100:234–241.
- Jarvinen S. Indexes for orthodontic treatment need. *Am J Orthod Dentofacial Orthop.* 2001;120:237–239.
- Jenny J, Cons NC, Kohout FJ, Jakobsen J. Differences in need for orthodontic treatment between native Americans and the general population based on DAI scores. *J Public Health Dent.* 1991;51:234–238.
- Richmond S, Shaw WC, O'brien K, Buchanan IB, Stephens CD, Andrews M, and Roberts CT. The relationship between the index of orthodontic treatment need and the consensus opinion of a panel of 74 dentists. *Br. Dent. J.* 1995, 178, 370-374.)
- Cons NC, Jenny J, Kohout FJ. DAI: The Dental Aesthetic Index. Iowa City, Iowa: College of Dentistry, University of Iowa; 1986.
- Jenny J, Cons NC. Establishing malocclusion severity levels on the Dental Aesthetic Index (DAI) scale. *Aust Dent J.* 1996;41:43–46.
- Jenny J, Cons NC. Establishing malocclusion severity levels on the Dental Aesthetic Index (DAI) scale. *Aust Dent J.* 1996 Feb;41(1):43-6.
- WHO. Oral Health Surveys: Basic Methods. Geneva, Switzerland: World Health Organization; 1997.
- Abdullah MS, Rock WP. Assessment of orthodontic treatment need in 5,112 Malaysian children using the IOTN and DAI indices. *Community Dent Health.* 2001;18:242–248.
- Spencer AJ, Allister JH, Brennan DS. Utility of the Dental Aesthetic Index as an Orthodontic Screening Tool in Australia. Adelaide, Australia: University of Adelaide; 1992.
- Otuyemi OD, Ogunyinka A, Dosumu O, Cons NC, Jenny J, Kohout FJ, Jakobsen J. Perceptions of dental aesthetics in the United States and Nigeria. *Community Dent Oral Epidemiol.* 1998;26:418–420.
- Otuyemi OD, Ogunyinka A, Dosumu O, Cons NC, Jenny J. Malocclusion and orthodontic treatment need of secondary school students in Nigeria according to the dental aesthetic index (DAI). *Int Dent J.* 1999;49:203–210.
- Ansai T, Miyazaki H, Katoh Y, Yamashita Y, Takehara T, Jenny J, Cons NC. Prevalence of malocclusion in high school students in Japan according to the Dental Aesthetic Index. *Community Dent Oral Epidemiol.* 1993;21:303–305.
- Onyeaso CO. Orthodontic treatment need of Nigerian outpatients assessed with the Dental Aesthetic Index. *Aust Orthod J.* 2004;20:19–23.
- Maumela, Patricia Mutsinda, Application of the dental aesthetic index in the prioritization of orthodontic service needs. Thesis (M Med (Orthodontics))--University of Limpopo, 2010. <http://hdl.handle.net/10386/444>
- Drummond R J 2003: orthodontic status and treatment need of 12 – year old children in south Africa: an epidemiological study using the dental aesthetic index. thesis submitted to university of Pretoria for M Dent (Orthodontics).
- Shivakumara KM Chandub GN Shafiuallac MD. Severity of malocclusion and orthodontic treatment needs among 12- to 15-year-old school children of Davangere district, Karnataka, India. *European Journal of Dentistry.* *Eur J Dent* 2010;4:298- 307.
- Bernabe E, Flores – Mir C. Orthodontic treatment need in Peruvian young adult evaluated through dental aesthetic index. *Angles Orthod.* 2006; 76. 3: 417 – 21.
- Rwakatema DS, Nganga PM, Kemoli AM: Orthodontic treatment needs among 12 – 15 year olds in Moshi, Tanzania. *East Afr Med J.* May 2007. 226-232.
- Onyeaso CO, BeGole EAJ *Contemp Dent Pract.* 2006 May 1;7(2):87-94. Orthodontic treatment need in an accredited graduate orthodontic center in north america: a pilot study.
- Hlongwa P, Beane RA, Seedat AK, Owen CP. Orthodontic treatment needs: comparison of two indices. *SADJ.* 2004 Nov;59(10):421-4.
- Onyeaso CO (2004). Orthodontic treatment need of Nigerian outpatients assessed with the Dental Aesthetic Index. *Aust Orthod J* 20 (1): 19-23.

Table 5: Frequency distribution (%) malocclusion traits according to DAI components compared in different populations where the "Index for comparison" was matching.

| DAI component | Index for comparison | Nigeria (Otuyemi et al) | Moshi (Rwakatema et al) | South Africa (Drummond et al) | Peru (Bernabe et al) |
|--------------------------------------|----------------------|-------------------------|-------------------------|-------------------------------|----------------------|
| Missing teeth | ≥ 1 | 3.7 | 6.9 | 9.5 | 16.5 |
| Crowding (incisal segments) | 1 - 2 | 33.6 | 41.2 | 40 | 90.6 |
| Spacing (incisal segments) | 1 - 2 | 44.2 | 28.4 | 27.6 | 25.1 |
| Diastema (mm) | ≥ 1 | 24.9 | 20.1 | 16.7 | 13.1 |
| Anterior maxillary irregularity(mm) | ≥ 1 | 12.1 | 46 | 59 | 67.1 |
| Anterior mandibular irregularity(mm) | ≥ 1 | 29.2 | 51.6 | 53 | 85.4 |
| Maxillary Overjet (mm) | ≥ 3 | 14.1 | 12.1 | 43 | 20.6 |
| Mandibular Reversed overjet (mm) | ≥ 0 | 1.4 | 0.3 | 10.4 | 2.6 |
| Openbite (mm) | ≥ 0 | 10.2 | 6.2 | 7.7 | 1.9 |
| Molar relationship | ≥1/2 cusp | 16.2 | 32.5 | 44.5 | 52.1 |

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23. Poonacha KS, Deshpande SD, Shigli AL 2010, Dental aesthetic index: applicability in Indian population: A retrospective study. *J Ind. Soc. Prev. Paed. Dent.* 201, 28,1: 13-17.
 24. Cavalcanti AL, de Santana Sarmiento DJ, Santos JA, Moura C, Granville-Garcia AF. Prevalence of malocclusion and orthodontic treatment need in Brazilian adolescents. *Hellenic Orthod Review.* 2008; 11:2:91-9.
 25. Garbin AJÍ, Perin PCP, Garbin CAS, LLF. Malocclusion prevalence and comparison between the Angle classification and the Dental Aesthetic Index in scholars in the interior of São Paulo state – Brazil *Dental Press J Orthod* 2010 July-Aug;15(4):94-102.
 26. Huang WJ, Creath CJ. The midline diastema: a review of its etiology and treatment. *Ped. Dent.* 1995;17(3):171-79.
 27. Ciuffolo F, Manzoli L, D'attilio M et al. Prevalence and distribution by gender of occlusal characteristics in a sample of Italian secondary school students. A cross sectional study. *Eur. J. Orthod.* 2005;27:601-6.
 28. Beane RA, Reimann G et al. A cephalometric comparison of Black open bite subjects and Black normals. *Angle Orthod.* 2003; 73: 294-300.