British Journal of Medicine & Medical Research
7(6): 519-528, 2015, Article no.BJMMR.2015.358
ISSN: 2231-0614

SCIENCEDOMAIN *international*
www.sciencedomain.org

Relationship between Two Indices in the Assessment of Orthodontic Treatment Complexity and Need

Ifeoma Linda Utomi[1*] and Chukwudi Ochi Onyeaso[2]

[1]Department of Child Dental Health, Faculty of Dentistry College of Medicine, University of Lagos, University of Lagos Teaching Hospital (LUTH), Lagos, Nigeria.
[2]Department of Child Dental Health, Faculty of Dentistry College of Health Sciences, University of Port Harcourt, University of Port Harcourt Teaching Hospital (UPTH), Port Harcourt, Nigeria.

Authors' contributions

This work was carried out in collaboration between the two authors. ILU was responsible for conceptualization of research topic, study design, data collection, interpretation of results, critical review and editing. COO was responsible for study design, critical review and editing. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BJMMR/2015/14066
Editor(s):
(1) Toru Watanabe, Department of Pediatrics, Niigata City General Hospital, Japan.
(2) Oswin Grollmuss, Department of Pediatric and Adult Resuscitation Congenital Heart of Centre Chirurgical Marie Lannelongue, University Paris XI, France.
Reviewers:
(1) Anonymous, Spain.
(2) Maen Mahfouz, Arab American University Jenin, Palestine.
(3) Anonymous, Morocco.
(4) Anonymous, Brazil.
(5) Anonymous, Iran.
Complete Peer review History: http://www.sciencedomain.org/review-history.php?iid=946&id=12&aid=8318

Original Research Article

Received 16th September 2014
Accepted 12th January 2015
Published 3rd March 2015

ABSTRACT

Objective: To determine the relationship between the Index of Complexity, Outcome and Need (ICON) and Dental Aesthetic Index (DAI) in the assessment of orthodontic treatment complexity and need.
Methods: A cross-sectional study was carried out. Pre-treatment dental casts of 150 consecutive patients from Lagos, Nigeria were assessed using the ICON and the DAI criteria. One investigator assessed all the models. In addition to descriptive statistics, the relationship between the ICON and DAI was examined by using non-parametric correlations (Spearman Rank Order and Pearson's Product Moment Correlation Coefficient.

**Corresponding author: Email: ifeomautomi@yahoo.com;*

Results: Forty-five (30%) of the subjects were classified by both ICON and DAI as having no treatment need. Of the 25(16.7%) that ICON classified as having difficult / very difficult complexity grades, 19(12.7%) of them were classified as having handicapping malocclusions by DAI standards. There was a significant correlation between DAI and ICON with regard to treatment need ($p = 0.000$). Also, there was a very statistically significant correlation between the ICON complexity grades and the DAI severity levels of malocclusion ($p = 0.000$). In general, both indices exhibited highly significant positive correlations ($r = 0.600$; $p = 0.000$).
Conclusion: Both indices were generally in agreement on both aspects of orthodontic provision assessed. This suggests that both ICON and DAI can be used in the assessment of these facets of orthodontic care.

Keywords: Orthodontics; indices; patients; Nigeria.

1. INTRODUCTION

The increasing global demand for clinical effectiveness and audit of healthcare services has generated a need to standardize methods of measurement. The severity or the extent to which a malocclusion deviates from the normal or ideal occlusion can be quantified by using an occlusal index [1]. Several authors have studied, in other fields of dentistry, the reliability of some measurement indices and their suitability for mass screening programmes [2]. Various indices have been used to assess different aspects of orthodontic provision [3-10]. It is expected that these indices would enable a valid comparison between orthodontic provision in different services and in different countries. However, over the years, very few of these indices have received international acceptance.

Of the indices currently available, the Dental Aesthetic index (DAI) has been accepted by the World Health Organization as a cross-cultural, international index [11,12]. The DAI was designed primarily to provide objective measures of aesthetics and associated psychological handicaps based on 10 occlusal traits evaluated from pretreatment study models [10,11]. It has been utilized for objective assessment of treatment need from study models or patients [8,10,11]. It is an index for orthodontic treatment need assessment that has the ability to grade malocclusions on study models or patients into four severity categories [10-16].

Although the DAI has various acceptable qualities such as high reliability, validity [11] and ability to prioritize orthodontic care in publicly financed programmes, it has limitations. For example, it excludes missing molars, impacted teeth, posterior cross bites, and midline discrepancies in the computation of its score. Consequently, its aesthetic assessment of cases may not be comprehensive enough [17].

The Index of Complexity Outcome and Need (ICON) was derived from the subjective judgment of 97 practicing specialist orthodontists from countries including (Germany, Greece, Hungary, Italy, Netherland, Norway, Spain, United Kingdom, United States) on 240 initial and 98 treated study models [6]. It is a single assessment protocol to record treatment complexity, outcome and need and is designed for use on patients or study models [6,18]. The high validity of the ICON has been reported [19] and several studies have documented its good reliability [20-22]. The ICON is easier and more efficient to use than separate indices in assessment of the various facets of orthodontic treatment.

In recent years, there has been increasing emphasis and demand for clinical effectiveness and accountability of health care services including orthodontic services. Therefore, the ICON would be a useful tool for audit and a basis for quality assurance standards in orthodontic provision and also provide a basis for international comparison of data. In this regard, the ICON would be a useful tool for orthodontic centres of both the developing and developed countries of the world.

Nigeria is Africa's most populous country with a population of over 150 million people. Lagos is a highly cosmopolitan urban city and the commercial capital of Nigeria. The practice and teaching of orthodontics in Nigeria started at the Lagos University Teaching Hospital over 3 decades ago and it is a major referral centre. It provides dental care including orthodontic care for a broad spectrum of patients from all the three major Nigerian ethnic groups. Over the years, there has been an increase in the

availability of orthodontic services with a corresponding demand for orthodontic care.

Since the inception of the orthodontic practice in Nigeria, there have been several reports on orthodontic treatment need in the Nigerian population, using the DAI [16,23-33] alone and some using the ICON [34-36]. Recent Nigerian studies that evaluated the relationship between ICON and DAI suggest that the ICON could replace the DAI as a valid index in assessing orthodontic treatment need in Nigerian patients [35,36]. However, the only such previous clinic-based study in Nigeria [35] was a retrospective pilot study in a different Nigerian city (Ibadan) and with a relatively small sample of 56 subjects. However, to the best knowledge of the authors, no other such study has previously been conducted in any other part of Nigeria especially in Lagos, Nigeria with a major orthodontic referral centre. As a major referral centre, patients with a broad range of malocclusions and severities are seen in its orthodontic clinic. Furthermore, Lagos, the commercial nerve centre and former capital of Nigeria has a very diverse population widely representative of the various ethnic groups in Nigeria. It was, therefore, considered necessary to conduct such a study in Lagos, Nigeria.

This study aimed at evaluating the relationship between the ICON and the DAI in the assessment of orthodontic treatment complexity and need of orthodontic patients in Lagos, Nigeria. It is hoped that this would provide further evidence-based rationale for the use of ICON alone in the assessment of these facets of orthodontic treatment in Nigerian patients.

2. MATERIALS AND METHODS

This cross-sectional study was carried out at the Orthodontic Unit of the Lagos University Teaching Hospital, Lagos, Nigeria. The study sample population consisted of 150 pre-treatment study models of consecutive patients aged 10 to 40 years, who were scheduled for treatment at the Orthodontic clinic of the Lagos University Teaching Hospital between June, 2011 and December, 2012. The study models used in this study had been made by graduate orthodontic residents assigned to treat these patients and constituted part of the standard orthodontic records domiciled in the clinic for each patient.

The sample size was calculated to achieve a power of 80%, confidence level of 95% and degree of error of 0.05. [37] Based on (p) the proportion of malocclusion in a previous study [34], it was determined that 141 study models were needed. This was then rounded up to 150 study models.

The inclusion criteria were no previous orthodontic treatment and willingness to participate in the study. The exclusion criteria were a history of orthodontic treatment and craniofacial anomalies (clefts and syndromes). Patients who met all inclusion criteria were enrolled and informed consent obtained. The study casts of the patients were used for the assessments. The pretreatment models were assigned serial numbers and were then scored for orthodontic treatment complexity and need using the Index of Complexity, Outcome and Need (ICON) as shown in Table 1 [5]. The same models were also evaluated according to criteria for the Dental Aesthetic Index (DAI) as shown in Table 2. One of the authors, (ILU), previously trained and calibrated examined all the models in strict adherence to the guidelines for both ICON and DAI. The assessed variables were entered into an evaluation form for the ICON and DAI indices. This procedure was similar to that described by Onyeaso [34].

The treatment need according to ICON was classified into 'no treatment' when total ICON score was less than 43 and 'treatment need' when ICON score was equal or more than 43. The orthodontic treatment complexity according to total ICON scores was graded into easy (<29), mild (29-50), moderate (51-63), difficult (64-77) and very difficult (>77) [35].

For the DAI, the total scores were categorized using standard criteria– normal or minor malocclusion with no treatment need or slight need (≤ 25), definite malocclusions with treatment considered elective [26-30], severe malocclusions with treatment highly desirable [31-35] and very severe or handicapping malocclusion with treatment considered mandatory (≥ 36) [35].

2.1 Intra-examiner Reliability Tests

To calculate the intra-examiner reliability, fifteen pre-treatment casts were randomly selected and evaluated. The same pre-treatment models were re-examined 4 weeks after the initial examination the two examinations were assessed statistically using both Pearson Product Moment Correlation Coefficient and Spearman Rank Correlation Coefficient [35]. The attained reliability was

satisfactory (With regard to Pearson, ICON: r =0.995, P = 0.000; DAI: r = 0.992, P = 0.000; With regard to Spearman, ICON r = 0.994, P = 0.000; DAI: r = 0.985, P = 0.000).

2.2 Statistical Analysis

The data was analyzed statistically using the SPSS statistical package (Statistical Package for the Social Sciences Version 17.0 for windows 2009, SPSS, Inc, Chicago, Ill, U.S.A. In addition to descriptive statistics, parametric and non-parametric statistics were used in the analysis of the data. A test of association was used to determine the ability of ICON and DAI to identify the same treatment needs as well as to determine the relationship between severity of malocclusion according to DAI and the complexity of cases using the ICON. The non-parametric correlations (Spearman Rank Order and Pearson's Product Moment Correlation Coefficient) were used to test the relationship between the two indices. P-values of less than 0.05 were considered as statistically significant [35].

3. RESULTS

There were 92(61.3%) females and 58(38.7%) males between 10 and 40 years of age. The mean age was found to be 16.9±7.7 (SD).

The assessment of sample based on ICON and DAI criteria showed a mean score of 43.0±17.8 (SD) and 31.5±9.7 (SD), respectively (Table 3). A test of the association between ICON and DAI treatment need groups showed that there was a statistically significant relationship between the two indices as shown in Table 4 (X^2 = 47.3; P = 0.000). While DAI categorized 49 (32.7%) of the subjects as having slight or no treatment need, 45(30%) of them were categorized by ICON criteria as having no orthodontic treatment need also. Similarly, using DAI standards 42 (28%) of the subjects were classified as belonging to the very severe/handicapping malocclusion group, while ICON classified 31(20.7%) as belonging to the treatment need group.

The relationship between ICON complexity grades and the DAI severity levels groups is shown in Table 5. This shows that there is a very statistically significant association between the orthodontic treatment complexity grades of the malocclusion according to ICON and the DAI severity level groups (X^2 = 61.3; P = 0.000). Regarding orthodontic treatment complexity, ICON classified 34(22.7%) as having easy complexity, while DAI classified 26(17.3%) of them as having little or no need for orthodontic treatment and 6(4.0%) as having definite malocclusion orthodontic treatment considered as elective. According to ICON, 25(16.7%) had difficult/very difficult grades of complexity while according to DAI 19(12.7%) had severe/very severe (handicapping) malocclusion.

The Pearson Product Correlation Coefficient was used to assess the relationship between the orthodontic treatment need according to DAI and the ICON determined orthodontic treatment need (Table 6). There was statistically significant positive correlation between the two indices (r = 0.600; p = 0.000). Fig. 1 shows the graphic distribution of the ICON and DAI scores for the whole sample.

4. DISCUSSION

One of the major outcomes of this study was the highly significant agreement between orthodontic treatment need as scored by both the ICON and the DAI. Another interesting finding was the significant concordance between the orthodontic treatment complexity according to ICON and the severity of malocclusion according to the DAI. Also the ICON was found to be simpler to use and faster to register. With the increasing cost of healthcare in the presence of rising demands and limited resources, there is a need to improve quality of care, decrease cost and improve outcomes. The ICON holds great promise as a unified index for the evaluation of the various components of orthodontic care delivery. It has been acknowledged for its cost-effectiveness [38]. Furthermore, the high validity of the ICON has been documented and previous studies have reported that it has good reliability [19,39].

The sample size in this study is larger than the 56 and 100 retrospective samples used in the analysis of similar Nigerian and North America studies [35,14]. It is, however, similar to the latter studies [35,14] in that it had a broad range of malocclusions and severities. The pretreatment sample used in the present study is similar to that used in some previous reports [35,36]. It however differs from that of the UK [40] and North American studies [14] which consisted of pretreatment and post treatment models. These latter studies [14,40] assessed treatment outcome whereas our study did not.

Table 1. The ICON scoring method and its components (Daniels and Richmond, 2000) [6]

Component	Score						
	0	**1**	**2**	**3**	**4**	**5**	**Weight**
1. Aesthetic assessment	Score 1 to 10						7
2. Upper arch 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	5
Upper arch spacing	<2 mm	2.1 to 5 mm	5.1 to 9 mm	>9 mm		Impacted teeth	5
3. Crossbite	No Crossbite	Crossbite present					5
4.Incisor open bite	Edge to Edge	< 1 mm	1.1 to 2 mm	2.1 to 4 mm	>4 mm		4
Incisor overbite	<1/3 lower incisor coverage	1/3 to 2/3 coverage	2/3 up to fully covered	Fully covered			4
5.Buccal segment anteroposterior	Cusp to embrasure Only classI, II or III	Any cusp relation up to but not including cusp to cusp	Cusp to cusp				3

Table 2. The standard DAI regression equation

	DAI components	**Weights**
1.	Number of missing visible teeth (incisors, canine and premolar teeth in the maxillary and mandibular arches)	6
2.	Crowding in the incisal segments: 0 = no segment crowded. 1 = 1 segment crowded, 2 = 2 segments crowded	1
3.	Spacing in the incisal segments: 0 = no spacing, 1 = 1 segment spaced, 2 = 2 segments spaced	1
4.	Midline diastema in millimeters	3
5.	Largest anterior irregularity in the maxilla in millimeters	1
6.	Largest anterior irregularity in the mandible in millimetres	1
7.	Anterior maxillary overjet in millimeters	2
8.	Anterior madibular overjet in millimeters	4
9.	Vertical anterior operibite in millimetres	4
10.	Antero-posterior molar relation: Largest deviation from 3 normal either left or right: 0 = normal, 1 - ½ cusp either mesial or distal, 2 = one full cusp or more either mesial or distal	3
11.	Constant	13
	Total	**DAI score**

DAI score = (Measured component x Weight) + Constant

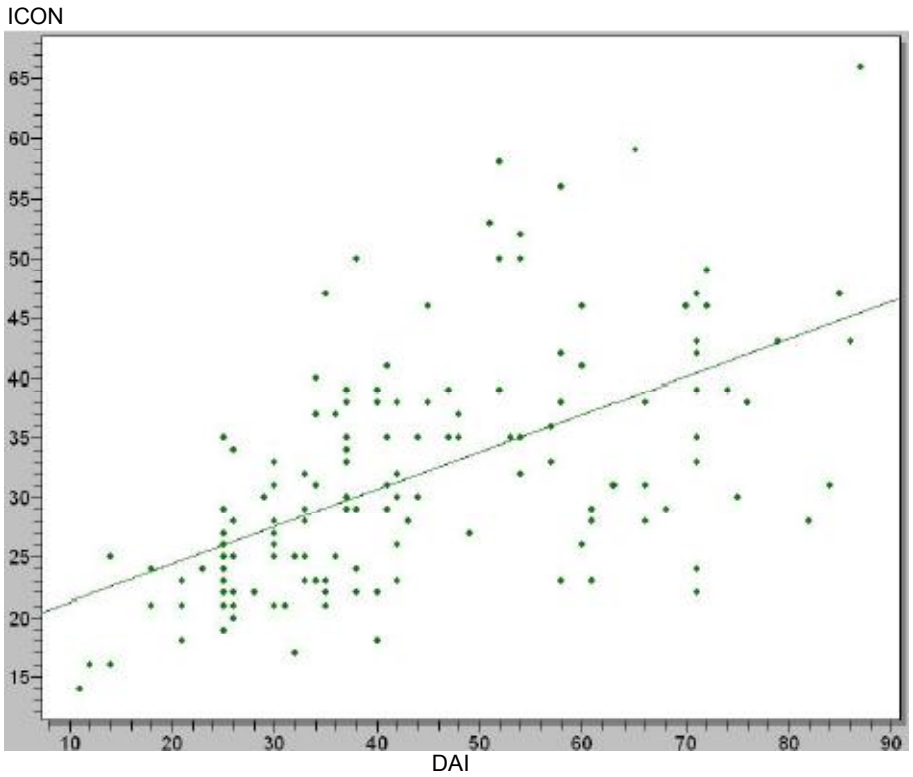

Fig. 1. Graphic presentation of pretreatment ICON and DAI scores of the 150 orthodontic cases

Table 3. Mean ICON and DAI scores, standard deviation and standard error means

Index	N	Mean	Standard deviation	Standard error
ICON	150	43.0	17.8	2.423
DAI	150	31.5	9.7	1.262

Table 4. Cross-tabulation of ICON and DAI treatment need groups

ICON score	DAI score				
	≤ 25	26-30	31-35	≥36	Total
< 43	45 (48.0)	25 (27.0)	12 (13.0)	11 (12.0)	93 (100)
43 and above	4 (7.0)	10 (17.5)	12 (21.1)	31 (54.4)	57 (100)
Total	49 (33.0)	35 (23.0)	24 (16.0)	42 (28.0)	150 (100)

X2 = 47.3, p = 0.000

Table 5. ICON Complexity grades versus the severity levels of malocclusion according to the DAI

ICON score	DAI score				
	≤ 25	26-30	31-35	≥36	Total
Easy	26 (76.0)	6 (18.0)	2 (6.0)	0 (0.0)	34 (100)
Mild	19 (27.5)	22 (31.9)	13 (18.8)	15 (21.7)	69 (100)
Moderate	2 (9.1)	3 (13.6)	5 (22.7)	12 (54.5)	22 (100)
Difficult	2 (10.5)	3 (15.8)	3 (15.8)	11 (57.9)	19 (100)
Very difficult	0 (0.0)	1 (16.7)	1 (16.7)	4 (66.7)	6 (100)
Total	49 (33.0)	35 (23.0)	24 (16.0)	42 (28.0)	150 (100)

X2=61.3, p = 0.000

Table 6. Correlation between ICON and DAI

	r	S.E	F test	P value
Pearson's Product correlation coefficient	0.6	0.04	78.3	0.000

In the present study, the mean ICON score was found to be 43.0±17.8 (SD). The mean ICON score recorded in this study is much lower than that (67.38±16.3 (SD)) reported by Onyeaso and Idaboh [34] in a Nigerian orthodontic population. Similarly, it was found to be lower than the mean values (69 and 72.5) documented by previous studies in Greece [41] and Sweden [42]. Relatively higher values (72.9±13 and 67.8) were also reported in demand populations in the UK [40] and North America [14] respectively. Previous Nigerian epidemiological studies [36,43] reported mean values of 41.93±15.38 (SD) and 39.7±25.3 (SD) respectively which compare well with that of the present study, However, Liepa et al. [20] reported an average mean ICON score of 42.05 for Daugavpils and Riga secondary school children in Latvia which compares well with that of the present study.

In this study, a highly significant relationship was found between orthodontic treatment need as assessed by ICON as well as by the DAI. This is in agreement with a previous Nigerian clinic-based study by Onyeaso [35]. In a similar study in North America [14], it was concluded that the ICON could replace the DAI in the assessment of pretreatment orthodontic need in the US. The study by Fox et al. [40] in the UK reported positive correlations between the ICON and IOTN and concluded that ICON may effectively replace IOTN as a means of determining treatment need and outcome. Also, the UK study [40] revealed a significantly positive association between subjective and professional assessment by both age and gender.

The findings of the present study revealed a highly significant correlation between the orthodontic treatment complexity according to ICON and the severity of malocclusion according to DAI. This concurs with the report of an earlier Nigerian clinic –based study [35]. The term complexity or difficulty has been used in the orthodontic literature to indicate the amount of effort required in the attainment of ideal or normal occlusion [36,44]. Difficulty of achieving an ideal or normal occlusion might lie with the severity of the pretreatment occlusion and also patient associated factors [1]. In the study by Cassinelli et al. [1], difficult cases were associated with more compliance problems, more frequent appointments and longer treatment duration than those considered as easy. Similarly, the studies by Richmond et al. [21], Onyeaso and Begole [45,46] showed that pretreatment ICON scores were significantly associated with duration of orthodontic treatment with cases having higher treatment score taking longer time to treat.

This present study has recorded a significant correlation between the ICON scores and DAI scores. The close agreement between the ICON and DAI scores of this present Nigerian study sample suggests that the ICON could substitute for the DAI in assessing pretreatment orthodontic needs among Nigerians. This present finding is not only consistent with those of earlier similar clinic-based studies [14,45] but also with that of a recent epidemiological report [36].

The ICON has relatively fewer characteristics to be measured than the DAI and was found to be relatively easier to learn, more simple to use, and faster to register than the DAI. These attributes should make it a preferable tool in the assessment of the various components of orthodontic provision.

5. CONCLUSION

The ICON is proposed as both time and cost-effective substitute for DAI in the assessment of pretreatment need of Nigerian orthodontic patients. This study has shown a positive significant relationship between the complexity of malocclusions as assessed by the ICON and severity of malocclusions as assessed by DAI. The ICON appears not only to be a reasonable means of assessing orthodontic treatment provision because of its ability to assess different aspects of orthodontic care but will continue to allow for international comparison of data.

ETHICAL APPROVAL

All the patients and their parents gave their consent before being recruited into the study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Cassinelli AG, Firestone AR, Beck FM, Vig KWL. Factors associated with orthodontists' assessment of difficulty. Am J Orthod Dentofacial Orthop. 2003;125:147-50
2. Miranda J, Brunet L, Roset P, Farre M, Mendieta C. The reliability of two measurement indices for gingival enlargement. J Periodontal Res. 2012;47:776-82.
3. Shaw WC, Richmond S, O'Brien KD. The use of occlusal indices: A European perspective. Am J Orthod Dentofacial Orthop. 1995;107:1-10.
4. Salzman JA. Handicapping malocclusion assessment to establish treatment priority. Am J Orthod. 1968;54:749-765.
5. Summers CJ. The occlusal index: A system for identifying and scoring occlusal disorders. Am J Orthod. 1971;59:552–566.
6. Daniels C, Richmond S. The development of an index of complexity, outcome and need (ICON) Br J Orthod. 2000;27:149-162.
7. Brook PH, Shaw WC. The development of an index of orthodontic treatment priority. Eur J Orthod. 1989;11:309-320.
8. Draker HL. Handicapping labiolingual deviations: A proposed index for public health purposes. Am J Orthod. 1960;46:295-305.
9. Richmond S, Shaw WC, O'Brien KD, Buchanan IB, Stephens CD, Roberts CT, Andrews M. The development of the PAR index (Peer Assessment Rating) reliability and validity. Eur J Orthod. 1992;14:125-139.
10. Cons NC. Jenny J, Kohout FJ. DAI: The Dental Aesthetic Index. Iowa City, Iowa University of Iowa; 1986.
11. World Health Organization International collaboration study of Oral Health Outcomes (ICS II), document 2: Oral data collection instrument and evaluative criteria. Geneva World Health Organization; 1989.
12. Cons NC, Jenny J. Comparing perceptions of dental aesthetics in the U.S.A. with those in eleven ethnic groups. Int Dent J. 1994;44:489-494.
13. Con NC, Jenny J, Kohout FJ, Songpaison Y, Jotipastira D. Utility of dental aesthetic index in industrialized and developing countries. J Pub Health. 1989;49:163-166.
14. Onyeaso CO, Begole EA. The relationship between index of complexity, outcome and need, dental aesthetic index, peer assessment rating index, and American Board of Orthodontics objective grading system. Am J Orthod Dentofacial Orthop. 2007;131:248- 252.
15. Jenny J, Cons NC. Establishing Malocclusion severity levels on the Dental Aesthetic Index. Aust Dent J. 1996;41:43-46.
16. Onyeaso CO. Orthodontic treatment need of Nigerian Outpatients assessed with the Dental Aesthetic Index. Aust Orthod J. 2004;20:19-23
17. Danyluk K, Lavelle C, Hassard T. Potential application of the dental aesthetic index to prioritize orthodontic treatment needs in a publicly funded programme. Am J Orthod Dentofacial Orthop. 1999;116:279-280.
18. Richmond S, Aylott NAS, Panahei MES, Rolfe B, Havzer W, Tausche E. A 2-Center Comparison of Orthodontist's perceptions of Orthodontic treatment difficulty Angle Orthod. 2001;71:404-410.
19. Firestone AR, Beck M, Beglin FM, Vig KWL. Validity of the index of complexity, outcome and need. Angle Orthod. 2002;72:15-20.
20. Liepa A, Urtane I, Richmond S, Dunstan F. Orthodontic treatment need in Latvia. Eur J. Orthod. 2003;25:279-284.
21. Richmond S, Ikonomou C, Williams B, Ramel S, Rolfe B, Kurol J. Orthodontic treatment standards in a public group practice in Sweden. Swed Dent J. 2001;25:137-144.
22. Richmond S. Ikonomou C, William B, Rolfe B. Orthodontic treatment standards in Greece. Hell Orthod Rev. 2001;4:9-20.
23. Otuyemi OD, Ogunyinka A, Dosumu O, Con NC, Jenny J. Malocclusion and Orthodontic treatment need of secondary school student in Nigeria according to the Dental Aesthetic Index (DAI). Int Dent J. 1999;49:203–210.
24. Onyeaso CO. Orthodontic treatment need of mentally handicapped children in Ibadan, Nigeria according to the Dental

Aesthetic Index. J Dent Child. 2003;70:159-163.

25. Onyeaso CO. Comparison of malocclusion and orthodontic treatment needs of handicapped and normal children in Ibadan, using the Dental Aesthetic Index. Niger Postgrad Med J. 2004;11:40-44.
26. Onyeaso CO. Orthodontic treatment need and demand in a group of Nigerian adults: a teaching hospital-based study. Odontostomatol Trop. 2004;27(107):32-36.
27. Onyeaso CO, Arowojolu MO, Taiwo JO. Periodontal status of orthodontic patients and the relationship between dental aesthetic index and community periodontal index of treatment need. Am J Orthod Dentofacial Orthop. 2003;124(6):714-20.
28. Onyeaso CO, Aderinokun GA. The relationship between dental aesthetic index (DAI) and perceptions of aesthetic, function and speech among secondary school children in Ibadan, Nigeria. Int J Paediatr Dent. 2003;13(5):336-41.
29. Onyeaso CO. Orthodontic concern of parents compared with orthodontic treatment need assessed by Dental Aesthetic Index (DAI) in Ibadan, Nigeria. Odontostomatol Trop. 2003;26(101):13-20.
30. Onyeaso CO, Arowojolu MO. Perceived, desired and normatively determined orthodontic treatment needs among orthodontically untreated Nigerian adolescents. West Afr J Med. 2003;22(1): 5-9.
31. Onyeaso CO. An assessment of relationship between self-esteem, orthodontic concern, and Dental Aesthetic Index (DAI) scores among secondary school students in Ibadan, Nigeria. Int Dent J. 2003;53(2):79-84.
32. Utomi IL, Onyeaso CO. Assessment of malocclusion and orthodontic treatment need in disabled children in Nigeria. J Dis Oral Health. 2007;8:3-8.
33. Utomi IL, Onyeaso CO. Malocclusion and Orthodontic treatment need of mentally handicapped children in Lagos Nigeria. Pesq Bras Odontoped Clin Integr. 2009;9:7-11.
34. Onyeaso CO, Idaboh G. Orthodontic treatment complexity and need at the University College Hospital, Ibadan, Nigeria according to the Index of Complexity, Outcome and Need (ICON): A pilot study. Ped Dent J. 2006;16:128-131.
35. Onyeaso CO. Orthodontic treatment complexity and need in a group of Nigerian patients: The relationship between the Dental Aesthetic Index (DAI) and the Index of Complexity, Outcome and Need (ICON). J Contemp Dent Pract. 2007;8:37-44
36. Onyeaso CO. Relationship between the Index of Complexity, Outcome and Need and Dental Aesthetic Index in the Assessment of orthodontic treatment complexity and need of Nigerian adolescents. Pesq Bras Odontoped Clin Integr. 2008;8:141-145.
37. Araoye MA. Research methodology with statistics for health and social sciences. Nathadex Publisher; 2003.
38. Dean J, Playle R, Durning P, Richmond S. An exploratory study of cost-effectiveness of orthodontic care in seven European countries. Eur J Orthod. 2009;31:90-94.
39. Savastano Jr NJ, Firestone AR, Beck M, Vig KWL. Validation of complexity and treatment outcome components of Index of complexity. Outcome and Need (ICON) Am J Orthod Dentofacial Orthop. 2003;124:244-8.
40. Fox N.A, Daniels C, Gilgrass T. A comparison of the index of Complexity, Outcome and Need (ICON) with the Peer Assessment Rating (PAR) and the Index of Orthodontic Treatment Need (IOTN). Br Dent J. 2001;193:225-230.
41. Richmond S. Ikonomou C, William B, Rolfe B. Orthodontic treatment standards in Greece. Hell Orthod Rev. 2001;4:9-20.
42. Richmond S, Ikonomou C, Williams B, Ramel S, Rolfe B, Kurol J. Orthodontic treatment standards in a public group practice in Sweden. Swed Dent J. 2001;25:137-144.
43. Aikins EA, daCosta OO, Onyeaso CO, Isiekwe MC. Orthodontic treatment need and complexity among Nigerian adolescents in Rivers State, Nigeria. Int J Dent. 2011;1-6.
44. Bergstrom K, Halling A. Comparison of three indices in evaluation of Orthodontic treatment Outcome. Acta Odontol Scand. 1997;55:36-43.
45. Onyeaso CO, BeGole EA. Orthodontic treatment standard in an accredited graduate orthodontic clinic in North

America assessed using the Index of Complexity, Outcome and Need (ICON). Hell Orthod Rev. 2006;9:23-34.

46. Onyeaso CO, BeGole EA. Orthodontic treatment need in an accredited graduate orthodontic center in North America: A pilot study. J Contemp Dent Pract. 2006; 7(2):87-94.

© 2015 Utomi and Onyeaso; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=946&id=12&aid=8318