PREVALENCE AND SEVERITY OF MALOCCLUSION IN BRAZILIAN ADOLESCENTS USING THE DENTAL AESTHETIC INDEX (DAI)

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ABSTRACT

Malocclusions and dental deformities mainly affect aesthetics and function. The objectives of this study were to evaluate the prevalence and severity of malocclusion and orthodontic treatment needs in adolescents from the northeast of Brazil aged between 13 and 17 years.

A sample of 434 schoolchildren aged 13 to 17 years, 231 boys and 203 girls, were randomly selected from 12 public schools in urban area. The sample selection was carried out in two stages: first, schools were selected by simple sampling, and then children were chosen using a proportionality coefficient. Data were collected through clinical examinations and interviews, after examiner calibration (k=0.88). Information regarding occlusal alterations (Dental Aesthetic Index) and subjective perceptions on occlusal pathologies were collected by means of structured questionnaires submitted to the students. Yates' chi-square test verified the association between the variables and odds ratio. Significance level was set at 5%.

The prevalence of malocclusion was 58.1% and there was no statistically significant gender difference of DAI scores (P=0.936). Sixty-seven percent of the children presented normal occlusion / mild occlusal pathologies (DAI ≤30) and 33% had severe / very severe or incapacitating occlusal pathologies (DAI >30). There were statistically significant differences between the variable anterior open bite and severity of occlusal pathologies (p<0.001).

Based on DAI criteria, a high prevalence of malocclusion was found and show the need of occlusal treatment for Brazo;oam adeloscent population.

Key Words: *Adolescent, Malocclusion, Brazilian population Self-Perception.*

INTRODUCTION

According to the concept of oral health-related quality of life (OHRQoL), good oral health is no longer seen as the mere absence of oral disease and dysfunction. The use of indicators of OHRQoL is necessary since they are based on self-perception and oral health impact, which is essential for planning of actions for health promotion considering biological and psychosocial aspects.

Malocclusions and dental deformities mainly affect aesthetics and function. Because dental aesthetics is an important element of facial appearance, poor dental appearance such as severe crowding in anterior teeth, or a median diastema, might negatively influence the general dentofacial appearance.[1] Moreover, the self-perceived level of the attractiveness or "positive" feelings toward the dentofacial region is a more important factor contributing to self-concept in preadolescents and adolescents than the self-perceived severity of the malocclusion alone.[2]

A large number of studies on the prevalence of malocclusion in different populations have been published.[3-8] Among Latino adolescents between the ages of 12 and

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18 years in the USA, more than 93% of the subjects demonstrated some form of malocclusion.[9] In Brazil, the reported prevalence vary from 31.6[10] to 65.1[11] per cent. Variables (including age differences of the study populations, examiner subjectivity, specific objectives, and differing sample sizes) further complicate efforts to understand and appreciate the differences recorded in patterns of malocclusion between ethnic groups.[9]

The Dental Aesthetic Index (DAI) links clinical and aesthetic components mathematically to produce a single score.[12] The DAI may be considered the most appropriate orthodontic treatment need index for conducting epidemiological studies in developing countries.[13] 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.[12]

The aim of this study was to assess the prevalence of malocclusion and orthodontic treatment need in a population of Brazilian adolescents.

METHODOLOGY

This study was conducted in compliance with the ethical guidelines issued by the Resolution 196/96 of the Brazilian National Health Council/Ministry of Health on research involving human subjects. The research project was independently reviewed and approved by the Ethics in Research Committee of the State University of Paraiba, Brazil.

Prior to data collection, the parents/caregivers were fully instructed by the examiner on the study purposes, relevance and possible benefits arising from its development. All parents/guardians were asked to sign a written informed consent form authorizing the enrollment of their children in the trial. Negative consent was accepted without any prejudice being attached to the children who had opted not to participate.

Sample

A cross-sectional survey was performed with the sample universe population constituted by all adolescents aged 12 to 18 years regularly enrolled in public and private schools in the city of Campina Grande, state of Paraiba, located in the northeast of Brazil. The city has an estimated population of 379,871 habitants and a municipal human development index (HDI) value of 0.72.

According to the data provided by the municipal Bureau of Education, there were 3,801 adolescents regularly attending public schools. For the sample calculation, a prevalence of 50%, a sample error of 5% and a confidence interval of 95% were adopted. A minimal sample size was established as 371 adolescents. In order to compensate for possible losses during the data collection, the decision was made to increase the sample by 20%, totaling 434 adolescents from 17 municipal schools. Students who had already finished their orthodontic treatment and those who were undergoing treatment at the time of the study were excluded. Exclusions also included those whose parents/legal guardians did not sign a free and informed consent form.

A stratified cluster sampling method was utilized, defining the students in the government schools of each of the 6 administrative areas of Campina Grande as 6 different strata. The schools (clusters) from each stratum as well as the classes from each school were randomly selected, and the number of students to be examined from each stratum was estimated according to proportions.

Measurements

A single calibrated examiner (Kappa = 0.88) performed all intraoral clinical examinations by direct visual inspection under good natural lightening with the adolescent sat on a chair in front of the examiner. Disposable gloves, tongue depressors, mouth mirrors and a millimetric periodontal probe were used. The necessary instruments and materials were sterilized and packed in sufficient amounts for each day of work. During the study, intra-examiner reliability was calculated by asking the raters to score 38 subjects twice within a 2-week period.

The DAI criteria for evaluation of occlusal anomalies were used.[12] The DAI evaluates dentofacial abnormalities based on information referring to three major aspects: dentition, space and occlusion. The dentition is evaluated by the number of lost permanent incisors, canines and premolars, which cause esthetic problems in the maxillary and mandibular arches. The space is evaluated based on the crowding in the incisal segment, spacing in the incisal segment, presence of incisal diastema and maxillary and mandibular anterior misalignment. The occlusion is evaluated based on measurements of the maxillary and mandibular anterior overjet, vertical anterior open bite and anteroposterior molar relationship. A questionnaire was administered to the adolescents including questions about appearance satisfaction (yes, no).

The DAI index provides four possible endpoints: absence of abnormality or mild occlusal pathology, with no need of treatment (DAI ≤25); defined occlusal pathology, with elective treatment (DAI = 26-30); severe occlusal pathology, with highly recommendable treatment (DAI = 31-35); very severe or incapacitating occlusal pathology, with mandatory treatment (DAI ≥36).

The variable "severity of the occlusal pathologies" was evaluated based on the dichotomization of DAI scores in: normal occlusion/mild occlusal pathologies (DAI ≤30) and severe/very severe occlusal pathologies (DAI >30).[11] The dichotomization of the severity of the malocclusions was based on the DAI scores and the corresponding necessity of treatment. In this way, a DAI value of 30 was established as a cutoff threshold; DAI values of 31-35 indicate severe malocclusions with highly desirable treatment and DAI values ≥36 correspond to malocclusions with strong need of treatment. To test reproducibility, 28 adolescents were re-examined for DAI data.

Statistical Analysis

All statistical analyses were performed using the Epi Info software (Centers for Disease Control and Prevention, Atlanta, GA, USA). The absolute and percent frequencies were obtained for data analysis (descriptive statistical techniques). The existence of significant association among the variables was verified by means of bivariate analysis (Yates' chi-square tests) considering a value of a=0.05 for rejection of the null hypothesis. Odds ratio (OR) was used for analysis of the strength and direction of association.

RESULTS

A total of 434 adolescents (231 [53.2%] males and 203 [46.8%] females) aged 13 to 17 years were examined and interviewed in this cross-sectional survey. The response rate was 100%. Because all the adolescents wanted to participate in the study, the sample size for the ages of 13 to 17 years was bigger than the estimated minimum size to satisfy the requirements, 74 adolescents of each age.

The prevalence of occlusal pathologies among the schoolchildren was 58.1% (n=252). Incisor, canine, and/or premolar teeth in maxillary arch were missing in 8.1 per cent (35 subjects). The prevalence of anterior open bite was 6.2 per cent (27 subjects). Regarding the severity of occlusal pathologies, 67% (n=291) of the children presented normal occlusion/mild occlusal pathologies (DAI ≤30) and 33% (n=143) had severe/very severe or incapacitating occlusal pathologies (DAI >30) (Table 1).

Overall, 40.1% of the adolescents reported dissatisfaction with their smile, and the prevalences for boys (29.4%) and girls (52.2%) were significantly different (P=0.000; OR= 2.61[1.76-3.88]).

There were no statistically significant differences between gender and severity of occlusal pathologies (P=0.936) and between the variable difficulty on mastication and severity of occlusal pathologies (P=0.709). However, dissatisfaction on smiling was strongly associated statistically with the severity of occlusal pathologies (P=0.001). A positive association was found between the dissatisfaction related to occlusal problems and severity of occlusal pathologies (P=0.027) (Table 2).

Table 3 presents the magnitude of the occlusal alterations based on their presence/absence in relation to the severity of the occlusal pathologies. There were statistically significant differences between the variables tooth crowding and severity of occlusal pathologies (P<0.001), tooth spacing and severity of occlusal pathologies (P=0.003), diastema and severity of occlusal pathologies (P<0.001) and between the variable anterior open bite and severity of occlusal pathologies (P<0.001).

DISCUSSION

For this cross-sectional study, a group of 13 to 17-year-old subjects were selected to provide preliminary information on the prevalence and severity of malocclusions in a Brazilian population.

Malocclusions and oral deformities mainly affect aesthetics and function and its impact on quality of life is substantial in children with low self-esteem.[14] Accurate information on the prevalence of various occlusal traits may also be needed when planning of certain orthodontic services involves targeting specific types of malocclusion at specific ages.[15] Traditional methods of estimating orthodontic need or evaluating treatment outcome are mainly based on normative need (NN) assessed by professionals, using occlusal or cephalometric measurements to define the need for or success/failure of treatment.[16]

The Dental Aesthetic Index (DAI) was selected for this study because it combines both the objective occlusal and the subjective esthetic aspects of the occlusion.[12]

TABLE 1: DISTRIBUTION OF THE TYPES OF OCCLUSAL PATHOLOGIES AND NEED OF TREATMENT IN THE 13 TO 17-YEAR-OLD ADOLESCENT POPULATION

Occlusal Conditions	n	%
Missing teeth (maxillary arch)		
None	402	92.6
One or more	32	7.4
Missing teeth (mandibular arch)		
None	423	97.5
One or more	11	2.5
Tooth crowding in the incisal segment		
No tooth crowding	117	27.0
Tooth crowding in one segment	156	35.9
Tooth crowding in two segments	161	37.1
Tooth spacing in the incisal segment		
No tooth spacing	283	65.2
Tooth spacing in one segment	97	22.4
Tooth spacing in two segments	54	12.4
Incisal diastema (mm)		
<2 mm	45	55.6
≥2 mm	36	44.4
Maxillary anterior misalignment		
<2 mm	94	41.2
≥2 mm	134	58.8
Mandibular anterior misalignment		
< 2 mm	145	58.0
≥ 2 mm	105	42.0
Maxillary anterior overjet		
< 4mm	191	45.7
≥ 4mm	227	54.3
Mandibular anterior overjet		
Absent	431	99.3
Present	3	0.7
Anterior open bite		
Absent	407	93.8
Present	27	6.2
Need of orthodontic treatment		
No need (≤25)	182	41.9
Elective (26-30)	109	25.1
Highly recommendable (31-35)	76	17.6
Mandatory (≥36)	67	15.4

TABLE 2: ASSOCIATION BETWEEN DISSATISFACTION ON SMILING AND DISSATISFACTION RELATED TO OCCLUSAL PROBLEMS AND THE SEVERITY OF THE OCCLUSAL PATHOLOGIES.

	Severity of the occlusal pathologies					
Variables	**DAI index ≤30**		**DAI index >30**		**OR (IC95%)**	**p-value**
Gender	n	%	n	%	1	
Male	154	66.7	77	33.3	1.03(0.69-1.55)	0.936
Female	137	67.5	66	32.5		
Dissatisfaction on smiling					1	
Yes	98	56.3	76	43.7	0.44(0.29-0.67)	0.001
No	193	74.2	67	25.8		
Difficulty on mastication					1	
Yes	75	65.2	40	34.8	1.11(0.71-1.75)	0.709
No	216	67.7	103	32.3		
Dissatisfaction related to occlusal problems					1	
Yes	64	50.8	62	49.2	2.35(1.15-4.80)	0.027
No	34	70.8	14	29.2		

TABLE 3: ASSOCIATION BETWEEN AS OCCLUSAL ALTERATIONS AND THE SEVERITY OF THE OCCLUSAL PATHOLOGIES.

	Severity of the occlusal pathologies					
Occlusal Alteration	**DAI index ≤30**		**DAI index >30**		**OR (IC95%)**	**p-value**
Tooth crowding	n	%	n	%	1	
Yes	197	67.7	120	83.9	2.48(1.49-4.14)	0.001
No	94	32.3	23	16.1		
Tooth spacing					1	
Yes	87	29.9	64	44.8	1.89(1.25-2.87)	0.003
No	204	70.1	79	55.2		
Diastema					1	
Yes	39	13.4	42	29.4	2.68(1.64-4.40)	0.001
No	252	86.6	101	70.6		
Mandibular overjet					1	
Yes	2	0.7	1	0.7	1.01(0.09-11.31)	0.547
No	289	99.3	142	99.3		
Anterior open bite					1	
Yes	3	1.0	24	16.8	19.3(5.72-65.52)	0.001
No	288	99.0	119	83.2		

The aesthetic component of the DAI is based on public perception of the dental aesthetics of 200 photographs of the occlusion. The disproportionate, stratified, random sampling procedure used in the selection of the 200 photographs ensured that even the most extreme cases would be represented.[17] Moreover, the DAI has been broadly used to determine orthodontic treatment need in epidemiological studies around the world over recent years[3,6-8] and has also been used in Brazil.[11,18]

Despite the favorable qualities of the DAI (such as high intra-examiner reliability, usefulness in allocating limited resources to handicapping malocclusions, and international applicability) the index is limited by its

inability to include some parameters such as missing molars, impacted teeth, posterior crossbites, and midline discrepancies in the computations of its case scores, thereby, limiting any comprehensive esthetic assessment.[8,19] In addition, DAI measurements are carried out using a millimetre gauge, and small errors in accuracy can have an exaggerated effect due to the index weightings.[17]

This cross-sectional survey has identified a prevalence of 58.1% of malocclusion among adolescents at the age of 13 to 17 years in Campina Grande, Brazil. This result was similar to previous report developed in other Brazilian cities[11,20] and lower than other developed by Marques et al.[21] Because different methodologies have been used in Latin American studies, so caution should be exercised when comparing prevalence figures. In addition, ethnic, physical and cultural characteristics are likely to contribute to differences in the prevalence of malocclusion.[10]

Findings of this study showed a higher dental loss on the maxillary arch than on the mandibular one, similar to previous Brazilian study[11], but lower than that observed among Indian[8] and Peruvian children.[13] The higher frequency of missing teeth in the Brazilian adolescents could be a reflection of the limited access to publicly funded dental care.

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.[8] In the present study, 73% of the adolescents presented dental crowding at least in one dental arch, which is a similar prevalence that reported in another study with Brazilian children[22], but higher than that observed among Japanese children[23]. Some studies have suggested that incisor crowding and median diastemas have the greatest negative impact on perceived intelligence and beauty, and people with crowding and median diastemas are judged to be from a lower social class than those with ideal occlusion[24]. The excessive anterior teeth display during smiling may potentially influence the self-perceived psychosocial impacts of malocclusion in adolescents depending on the severity level of malocclusion and the self-reported satisfaction with dental appearance.[25]

Anterior maxillary overjet is a measurement of the horizontal relationship of the incisors with the teeth in centric occlusion[8]. The prevalence of a maxillary anterior overjet ($\geq$4 mm, 54.3 per cent) found in the present investigation was lower than that reported among Japanese children[23] but higher than that observed among Brazilian[11], Colombian[26], Indian[8] and Peruvian children[13]. Differences in the definition of an increased overjet between the studies might have contributed to the variations in the reported results.[27]

Regarding the grading of orthodontics treatment needs, results of the present study were similar to previous reports in Latin American countries[11,13,20], but different from India[8] and Turkey.[17] Concerning the severity of malocclusion, 67% of the sample presented normal occlusion/mild malocclusion (DAI $\leq$30) and 33% had severe/very severe or incapacitating malocclusion (DAI >30).

Despite of previous study demonstrated a positive association between DAI scores and their distribution by gender[4], in this work there was no association between "gender" and "severity of the occlusal pathologies", in agreement with the findings of previous studies.[11,22]

It is therefore not surprising that adolescent girls are concerned with their facial attractiveness. The majority of patients who seek orthodontic treatment do so for aesthetic reasons[7], and girls are more likely to recognize dental irregularities and place more importance on this than boys.[17] Children and adolescents with malocclusion generally have both positive self-concept and positive self-esteem and that the body image of these subjects did not differ from that of the general population.[2]

During the last three decades, a notable increase in orthodontic treatment demand has occurred as a consequence of the high perception rate of malocclusions, along with a greater attention to aesthetics[28]. There was a statistically significant difference between the variable "dissatisfaction on smiling" and the DAI classification, in agreement with the findings of Nagarajan and Pushpanjali[7], Cavalcanti et al.[22] and Moura et al.[29] The self-perceived level of the attractiveness or "positive" feelings toward the dentofacial region is a more important factor contributing to self-concept in preadolescents and adolescents than the self-perceived severity of the malocclusion alone.[2]

Information on the perception of malocclusion can be used to influence decision making on the orthodontic services to be provided, human resource training needs, the design of treatment facilities, continuing education for oral health personnel, public health programs, screening for treatment priority, and resource planning. This information can also be used for patient education and information.[30]

Planning orthodontic treatment within a public health system requires information on the prevalence and distribution of malocclusions. Therefore, the results of present study are useful for public health planning. As the incidence of malocclusion may change or fluctuate in populations with time, follow-up studies are required.

CONCLUSION

Based on DAI criteria, a high prevalence of malocclusion was found and shows the need of occlusal treatment for this population.

REFERENCES

1 Zhang M, McGrath C, Hagg U. The impact of malocclusion and its treatment on quality of life: a literature review. Int J Paediatr Dent 2006; 16(6): 381-7.

2 Phillips C, Beal KN. Self-concept and the perception of facial appearance in children and adolescents seeking orthodontic treatment. Angle Orthod 2009; 79(1): 12-6.

3 Onyeaso CH. Relationship between 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(2): 141-5.

4 Van Wyk PJ, Drummond RJ. Orthodontic status and treatment need of 12-year-old children in South Africa using the Dental Aesthetic Index. SADJ 2005; 60(8): 334-8.

5 Zhang M, McGrath C, Hagg U. Orthodontic treatment need and oral health-related quality among children. Community Dent Health 2009; 26(1): 58-61.

6 Momeni Danaei S, Salehi P. Association between normative and self-perceived orthodontic treatment need among 12- to 15-year-old students in Shiraz, Iran. Eur J Orthod 2010; 32(5): 530-4.

7 Nagarajan S, Pushpanjali K. The relationship of malocclusion as assessed by the Dental Aesthetic Index (DAI) with perceptions of aesthetics, function, speech and treatment needs among 14- to 15-year-old schoolchildren of Bangalore, India. Oral Health Prev Dent 2010; 8(3): 221-8.

8 Shivakumar K, Chandu G, Shafiulla M. Severity of malocclusion and orthodontic treatment needs among 12- to 15-year-old school children of Davangere district, Karnataka, India. Eur J Dent 2010; 4(3): 298-307.

9 Silva RG, Kang DS. Prevalence of malocclusion among Latino adolescents. Am J Orthod Dentofacial Orthop 2001; 119(3): 313-5.

10 Peres KG, Barros AJ, Anselmi L, Peres MA, Barros FC. Does malocclusion influence the adolescent's satisfaction with appearance? A cross-sectional study nested in a Brazilian birth cohort. Community Dent Oral Epidemiol 2008; 36(2): 137-43.

11 Moura C, Leite Cavalcanti A. Severity of occlusal pathologies and associated factors in 12-year-old schoolchildren. Acta Odontol Latinoam. 2008; 21(2): 115-9.

12 Jenny J, Cons NC. Establishing malocclusion severity levels on the Dental Aesthetic Index (DAI) scale. Aust Dent J 1996; 41(1): 43-6.

13 Bernabé E, Flores-Mir C. Orthodontic treatment need in Peruvian young adults evaluated through dental aesthetic index. Angle Orthod 2006; 76(3): 417-21.

14 Agou S, Locker D, Streiner DL, Tompson B. Impact of self-esteem on the oral-health-related quality of life of children with malocclusion. Am J Orthod Dentofacial Orthop 2008; 134(4): 484-9.

15 Årtun J, Kerosuo H, Behbehani F, Al-Jame B. Residual need for early orthodontic treatment and orthodontic treatment experience among 13- to 14-year-old school children in Kuwait. Med Princ Pract 2006; 15(5): 343-51.

16 Gherunpong S, Tsakos G, Sheiham A. A socio-dental approach to assessing children's orthodontic needs. Eur J Orthod 2006; 28(4): 393-9.

17 Hamamci N, Başaran G, Uysal E. Dental Aesthetic Index scores and perception of personal dental appearance among Turkish university students. Eur J Orthod 2009; 31(2): 168-73.

18 Freire Mdo C, Reis SC, Gonçalves MM, Balbo PL, Leles CR. Oral health in 12 year-old students from public and private schools in the city of Goiânia, Brazil. Rev Panam Salud Publica 2010; 28(2): 86-91.

19 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; 1; 8(3): 37-44.

20 Marques LS, Barbosa CC, Ramos-Jorge ML, Pordeus IA, Paiva SM. Malocclusion prevalence and orthodontic treatment need in 10-14-year-old schoolchildren in Belo Horizonte, Minas Gerais State, Brazil: a psychosocial focus. Cad Saúde Pública 2005; 21(4): 1099-106.

21 Marques CR, Couto GB, Orestes Cardoso S. Assessment of orthodontic treatment needs in Brazilian schoolchildren according to the Dental Aesthetic Index (DAI). Community Dent Health 2007; 24(3): 145-8.

22 Cavalcanti AL, Sarmento DJS, Santos JA, Moura C, Granville-Garcia AF. Prevalence of malocclusion and orthodontic treatment need in Brazilian adolescents. Hellenic Orthod Rev 2008; 11(2): 91-9.

23 Takahashi F, Abe A, Isobe Y, Aizawa Y, Hanada N. Assessment of malocclusion of Japanese junior high school pupils aged 12-13 years in Iwate prefecture according to the Dental Aesthetic Index (DAI). Asia Pac J Public Health 1995; 8(2): 81-4.

24 Kerosuo H, Hausen H, Laine T, Shaw WC. The influence of incisal malocclusion on the social attractiveness of young adults in Finland. Eur J Orthod 1995; 17(6): 505-12.

25 Paula DF Jr, Silva ÉT, Campos AC, Nuñez MO, Leles CR. Effect of anterior teeth display during smiling on the self-perceived impacts of malocclusion in adolescents. Angle Orthod 2011; 81(3): 540-5.

26 Thilander B, Pena L, Infante C, Parada SS, de Mayorga C. Prevalence of malocclusion and orthodontic treatment need in children and adolescents in Bogota, Colombia. An epidemiological study related to different stages of dental development. Eur J Orthod. 2001; 23(2): 153-67.

27 Mtaya M, Brudvik P, Astrøm AN. Prevalence of malocclusion and its relationship with socio-demographic factors, dental caries, and oral hygiene in 12- to 14-year-old Tanzanian schoolchildren. Eur J Orthod 2009; 31(5): 467-76.

28 Perillo L, Masucci C, Ferro F, Apicella D, Baccetti T. Prevalence of orthodontic treatment need in southern Italian schoolchildren. Eur J Orthod 2010; 32(1): 49-53.

29 Moura C, Cavalcanti AL, Gusmão ES, de Souza Coelho Soares R, Cavalcante Moura FT, Hordonho Santillo PM. Negative self-perception of smile associated with malocclusions among Brazilian adolescents. Eur J Orthod (2012). doi: 10.1093/ejo/cjs022.

30 Mugonzibwa EA, Kuijpers-Jagtman AM, Van 't Hof MA, Kikwilu EN. Perceptions of dental attractiveness and orthodontic treatment need among Tanzanian children. Am J Orthod Dentofacial Orthop 2004; 125(4): 426-33..