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MALOCCLUSION AND ORTHODONTIC TREATMENT NEED AMONG 12-15-YEAR-OLD CHILDREN IN NAIROBI

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ABSTRACT

Objective: **To describe the pattern of occurrence of malocclusion and orthodontic treatment need.**
Design: **A descriptive cross-sectional survey.**
Setting: **Six public primary schools in Nairobi, Kenya.**
Subjects: **A randomly selected sample of 1382 children aged 12 to 15 years. Clinical examination for malocclusion was conducted using the Dental Aesthetic Index (DAI). Orthodontic treatment need was derived using the regression equation stated in the DAI.**
Results: **Among the 1382 (672 males and 710 females) children examined, 70 children (5.1%) had missing teeth. Crowding and spacing in the incisal segments occurred in 652 (47.2%) and 644 (46.6%) children respectively. Anterior irregularities were found in 533 (38.6%) of the subjects in the maxilla and 430 (31.1%) in the mandible. Anterior crossbite was found in 86 (6.2%) of the children. The anterior open-bite occurred in 194 (14%) of the children with significantly more open-bite in females than males (p=0007). The maxillary median diastema and antero-posterior molar relation discrepancies were found in 289 (20.2%) and 344 (24.9%) of the sample respectively. The sample mean DAI score was 26.6 (SD 7.8). Seven hundred and thirty two (53.0%) of the children examined had either no need or slight need for treatment whereas 650 (47%) were found with orthodontic treatment needs ranging from elective 318 (23%), highly desireable 176 (12.7%) to mandatory 156 (11.3%).**
Conclusion: **There was an overall high prevalence of malocclusion with 11.3% of the sample exhibiting handicapping malocclusion. Notably, there were no significant gender differences for most of the traits except for anterior open-bite which was found to occur more in females than males.**

INTRODUCTION

Malocclusion is a deviation from the normal intra and/or intermaxillary relationship of the teeth. The aetiology of malocclusion is considered multi-factorial with the two major factors influencing growth and development of the cranio-facial structures being hereditary influences and environmental causes (1). Majority of patients who present for orthodontic treatment do so due to concerns about dentofacial esthetics as they seek improvement in appearance. Other reported functions that may be impaired in persons with malocclusion include mastication, speech and pronunciation, emotional development and social contact (2). Mild forms of dentofacial deviation can predispose people to psychological distress and anxiety. Unfavorable consequences of malocclusion on oral health include: the risk of dental caries, trauma to maxillary incisors, predisposition to periodontal diseases and abnormality of stomatognathic function and temporomandibular joint dysfunction.

While several studies have been carried out locally to determine the prevalence of malocclusion, a literature search revealed a paucity of information in the last twelve years. In the latest edition of The World Health Organization, Oral Health Surveys, Basic methods, the Dental Aesthetic Index (DAI) has been incorporated to constitute criteria for assessing dento-facial anomalies (3). Hardly any study has been done in Kenya using this index. The purpose of this study, therefore, was to assess the pattern

of occurrence of malocclusion and determine the orthodontic treatment need in 12-15-year-olds in Nairobi using the DAI.

MATERIALS AND METHODS

This was a cross-sectional study involving 1382 children (672 males and 710 females) aged 12–15 years from 6 public primary schools in Nairobi. Sampling was done by the multi-stage cluster method in order to determine the schools that would be involved in the study. The City Council Education Department is divided into eight divisions and each division has two zones. Six divisions were initially randomly selected; one zone was then selected from each of the 6 divisions and thereafter one primary school was selected from each division.

The number of children to be examined in each school was obtained by proportionate sampling. In each of the schools selected, class registers for Standard 6, 7 and 8 (which were the classes where children aged 12 -15 years were found) were obtained and then study participants were randomly selected. Twelve-to-fifteen-year-olds were selected because this age group was expected to be in permanent dentition (children in mixed dentition were excluded from the study). Another reason that this age group was selected was for comparison with regional and international studies that have used a similar age group. Participants were examined in a classroom using natural light with the aid of dental mirrors and the marquis periodontal probe. Examination of the children was done by two trained persons: one the principal investigator (MKM) and a community oral health officer. During the data collection, the data collection assistants recalled every 10th child for re-examination by the 2 data collectors without them being informed. One hundred and thirty five children were re-examined. Kappa values for intra and inter-examiner variability of qualitative variables of DAI components were 0.92 and 0.91 respectively. There was no significant difference for continuous variables of the DAI components for the 135 re-examined subjects (p>0.05).

Registration for malocclusion was done using the DAI criteria (3). The variables assessed using this index included missing teeth, crowding, spacing, presence of diastemata, maxillary and mandibular irregularity, maxillary overjet, mandibular overjet, vertical anterior open-bite and antero-posterior molar relation. A structured questionnaire was used to obtain information on the malocclusion. Final individual DAI score points were calculated using the regression equation (4). An individual final DAI score which indicated severity of malocclusion also determined the subject's orthodontic treatment need according to the cut-off points of treatment categories. Treatment categories were DAI scores of <25 which indicated no or minor orthodontic treatment need and 26-30 which indicated elective orthodontic treatment need. DAI scores of 31-35 and >36 indicated highly desirable and mandatory orthodontic treatment need. Data were analysed aided by a computer using the Statistical Package for Social Sciences (SPSS) program, version 12.1. The Chi-square test was used to evaluate for any significant differences between males and females on the prevalence of malocclusion according to the DAI. A p value of less than 0.05 was considered significant. This study was approved by the Ethics and Research Committee of the Kenyatta National Hospital and University of Nairobi (Ref. No. KNH-UON ERC/01/3593).

RESULTS

Among the 1382 participants in the present study, 70 (5.1%) exhibited missing incisor, canine and premolar teeth. Crowding and spacing in the incisal segments were present in 652 (47.2%) and 644 (46.6%) subjects respectively. There was no significant gender difference for crowding (X^2=0.758; p=0.685) and spacing (X^2=4.037; p=0.133). Anterior irregularities were found in the maxilla at 533 (38.6%) with 276 (38.9%) of the participants having been female and 257 (38.2%) males. There was no statistically significant difference in the anterior maxillary irregularity in relation to gender (X^2=0.068. p=0.794). Incisor irregularity in the mandibular arch was found in 430 (31.1%) of the subjects examined among whom 220 (32.7%) were male and 210 (29.6%) female. There was no significant difference in the anterior mandibular irregularity in relation to gender (X^2=1.565, p=0.211). Two hundred and eighty nine (20.2%) subjects had dentitions that exhibited a midline maxillary diastema. The size of the diastemata ranged from 1-8mm. There was no statistically significant difference in the prevalence of the diastemata between the male and female subjects (X^2= 0.359; p=0.0549).

Subjects with a normal overjet of 1 to 3mm were 820, among whom 380 (56.5%) were male and 440 (62%) were female. Those with an overjet of 4 to 6mm constituted 246 (36.6%) male and 220 (31%) female. An overjet of greater than 7mm was encountered among 18 (2.7%) male and 18 (2.5%) female subjects. The edge to edge incisor relationship was exhibited by 28 (4.2%) male and 32 (4.5%) female participants.

Anterior cross-bite was elicited in 86 (6.2%) of the subjects and there was no statistically significant difference in the prevalence of this anomaly between gender (X^2=0.069, p=0.792). Anterior open-bite was registered in 194 (14%) of the children. Female children had a significantly higher prevalence of anterior open-bite than male children (X^2 =7.211, p=0.007). Antero-posterior molar relation discrepancies occurred in 344 (24.9%) of the children (Table 1).

The sample mean DAI score was 26.6(SD ± 7.8) which covered the 59.5 percentile of the scores. According to gender the mean DAI scores were 26.6(SD±7.4) and 26.6(SD±8.1) for males and females respectively.

Table 2 presents the orthodontic treatment need according to the DAI cut-off point for treatment categories. Seven hundred and thirty two (53%) of the subjects had either no need or slight need for treatment whereas 650 (47%) had orthodontic treatment needs ranging from elective at 318 (23%), highly desirable 176 (12.7%) to mandatory 156 (11.3%). There was no significant gender difference according to the categories of treatment need (p=0.139).

Table 1
*Distribution of unweighted DAI components (n=1382) and statistical
gender differences among children in Nairobi, Kenya*

Unweighted DAI component	Gender						P-value
	Male		Female		Total		
	No.	(%)	No.	(%)	No.	(%)	(chi-square)
Clinically missing teeth(≥1tooth)	37	5.5	33	4.7	70	5.1	0.47•
Crowding incisors (mm) 1-2 segments	325	48.4	327	46.1	652	47.2	0.69•
Spacing incisors (mm) 1-2 segments	314	46.7	330	46.4	644	46.6	0.13•
Maxillary median diastema(≥1mm)	136	20.2	153	21.5	289	20.2	0.55•
Largest anterior maxillary irregularity (≥1mm)	276	38.9	257	38.2	533	38.6	0.79•
Largest anterior mandibular irregularity (≥1mm)	220	32.7	210	29.6	430	31.1	0.21•
Increased maxillary overjet (≥4mm)	264	39.3	238	33.5	502	36.4	0.79•
Anterior crossbite (>0mm)	43	6.4	43	6.1	86	6.2	0.79•
Anterior vertical open-bite (>0mm)	77	11.5	117	16.5	194	14	0.007▼
Antero-posterior molar relation (≥1/2 cusp width)	175	26.1	169	23.8	344	24.9	0.51•

•=p>0.05 (no significant gender difference); ▼=p<0.05 (females more than males)

Table 2
*Orthodontic treatment needs based on Dental Aesthetic Index criteria
among children in Nairobi, Kenya*

	Treatment needs							
	No or slight need		Elective		Highly desirable		Mandatory	
Variable								
	(≥25 DAI score)		(26-30 DAI score)		31-35 DAI score		≥36 DAI score	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)
Male	672	48.6	340	50.6	168	25.0	93	13.8	71	10.6
Female	710	51.4	392	55.2	150	21.1	83	11.7	85	12.0
Total	1382	100	732	53.0	318	23.0	176	12.7	156	11.3

P=0.139

DISCUSSION

The DAI was developed as an epidemiological tool that links objective, clinical and subjective esthetic factors to produce a single score that reflects dental esthetics as well as orthodontic treatment need (4,5). This allows orthodontic public health or orthodontic insurance programs to screen and identify persons eligible for such programs on the basis of their objective and subjective esthetic needs. This can then allow better use of limited available resources in developing countries like Kenya. Furthermore, the WHO recently endorsed the DAI as a suitable cross-cultural index for use in epidemiological surveys (3). Otuyemi *et al*. (6) in a study aimed at determining the perceptions of dental aesthetics by Nigerian students reported that the standard DAI could be used without modification in Africans thus suggesting that different racial and cultural groups may share a common conception of beauty and that certain perceptions of dental aesthetics among different ethnic and racial groups are similar. All these reasons made the DAI a suitable index. Since no radiographs or impressions for study models were taken, it is likely that there may have been an over- or underestimation of some of the occlusal traits observed such as missing teeth.

Missing incisors, canines and premolars were observed in 5.1% of the children in the current study which was a slightly lower prevalence than the 6.3% reported by Ng'ang'a and Ng'ang'a (7) and 6.9% reported by Rwakatema *et al* (2007) in a study of 298 Tanzanian children aged 12–15 years using the DAI criteria. The difference between the current study and that of Ng'anga' and Ng'ang'a's study could be explained by the fact that they studied a selected sample seen at a private clinic and used radiographs to compliment clinical examination. The current study has shown that out of the 70 children with missing teeth, 75.7% had one or two missing teeth which is in line with the previous findings of 80% (7). Rwakatema *et al.* (18) reported a slightly higher prevalence than the current study and could possibly be explained by their smaller sample size and also probably by the ethnic differences among Kenyan and Tanzanian children.

The present study found an overall of 47.2% children with crowding in the incisal segments. This was much higher than that reported in two previous studies in Mandera (8) and Nairobi (9) of 16% and 19% respectively. Comparisons with these studies should be made with caution due to the fact that different diagnostic criteria were used for the two studies. Crowding (using the DAI criteria) in at least one dental arch was reported in 33.6% of Nigerians (10) and in 41.2% of Tanzanian 12-15-year-olds (11), percentages that were similar to the present study. The prevalence of spacing in this population (46.6%) was similar to that of Nigerian

adolescents (10) but much higher than 27.7% (12) reported in 12-year-old South African children. The South African study included Black, White, Asian and Coloured children hence the difference with the current study is not suprising.

The frequency of Nairobi children with an anterior maxillary irregularity was 38.6% while anterior mandibular irregularity was found in 31.1% of the children. These values were lower than those reported in Tanzanian children (11) for anterior maxillary irregularity (46.0%) and anterior mandibular irregularity (51.6%). The sample size in this study was different from the Tanzanian study and, therefore, comparisons may not be made objectively. Twenty percent of the children in the present study had midline maxillary diastema thus supporting a previous Kenyan study (9). The current study indicates that the predominant antero-posterior molar relationship was normal, which is a common finding in Kenya and elsewhere in the world (8, 11, 13, 14). Categorisation of malocclusion into half cusp and full cusp has not been reported before in studies of malocclusion in Kenya. Half and full cusp discrepancy was found in 24.9% of the current sample thus falling within the range (16.2%-32.5%) reported by other researchers in Tanzania and Nigeria (11,10) but much lower than data from Hungary, South Africa and Peru (13, 12, 15) which have reported this to range from 44.5%-52.1%.

According to Moyers (16) an overjet of between 1mm and 3mm is considered normal. The results of the current study indicated that 59.3% of the subjects presented with a normal maxillary overjet thus corroborating those of vanWyk (12) in South African children. Occurrence of extreme maxillary overjet ($\geq$6mm) (9.9%) was in agreement with previous findings by Ng'ang'a *et al*. (9) in Nairobi. Anterior cross-bite was found in 6.2% of the children a value somewhat higher than that reported by previous regional studies of 0%-1.4% (10, 11). Direct comparison of these studies should be done with caution because of differences in age-groups and sample size which may yield different results.

In the present study about 14% of the children presented with an anterior open-bite, a value similar to that reported in Nigerian adolescents (10) but about twice that reported in previous East African studies (9,11). The prevalence of anterior open bite in females was significantly higher than that in males (p=0.007) thus confirming the findings of van Wyk in South Africa (12). The actual cause of the male and female difference is unknown but one possibility could be that more females perform digit sucking thus predisposing them to developing the anterior open-bite.

Based on the DAI criteria (17) the present

study showed that 53% of the children had "none or slight" orthodontic treatment need ; 23% had "elective" treatment need; 12.7% were judged to have conditions for which orthodontic treatment was "highly desirable"; and 11.3% "mandatory" orthodontic treatment. These are in agreement with the findings of van Wyk *et al.* (12) who reported treatment need as none or slight in 47.7% of 12-year-old South African children, elective in 21.29%, highly desirable in 14.12% and mandatory in 16.89%. Our findings differ slightly from those of Rwakatema *et al.* (18) who reported a higher proportion (64.7%) of 12-15-year-old Tanzanian children having none or slight treatment need. They also showed a slightly lower percentage of children with severe and very severe/handicapping malocclusions in Tanzanian children (6.1%) when compared to Kenyan children. These disparities should be interpreted with caution due to sample size and sampling differences whereby a sample of 289 children participated in the Tanzanian study as compared to 1382 in the current study.

The current study reported a mean DAI of 26.6. Previous studies in Nigeria and Tanzania (10, 18) have reported a mean DAI of 22.3 and 24.6 respectively which fall under the category requiring no or slight treatment need while the mean of Nairobi adolescents falls into the category with elective treatment need. Katoh *et al.* (19) have reported a mean DAI score of 31.8 in Native Americans and 30.1 in the Japanese which is slightly higher than the current study. It would seem that Africans generally have better dental appearance and less orthodontic treatment need than Caucasians or Orientals (10).

The results of the present study indicate that the prevalence and severity of malocclusion for male and female children does not differ significantly (p=0.139) and thus are in accordance with previous studies (10,18). No Kenyan study using the DAI has been previously been reported.

In conclusion, crowding and spacing of the maxillary and mandibular arches are the commonest intra-arch anomalies observed in 12-15-year-olds in Nairobi. Eleven percent of the study participants had handicapping malocclusions and would benefit from subsidised orthodontic treatment by specialists.

REFERENCES

1. Profit, W. R. and Fields, H. W. The etiology of orthodontic problems In: Profit WR, Fields HW, eds. Contemporary Orthodontics. 3rd edn. *Missouri: Mosby,* 2000: pp 113-144.
2. Bernabe´ E., Tsakosb, G., Oliveirac, C. M. and Sheihamd A. Impacts on Daily Performances Attributed to Malocclusions Using the Condition-Specific Feature of the Oral Impacts on Daily Performances Index. *Angle Orthod* 2008; **2**:241-247.
3. World Health Organization. Oral Health Surveys, Basic methods. 4th edn. Geneva: World Health Organization, 1997.
4. Cons, N. C., Jenny, J. and Kohout, F. J. DAI: The Dental Aesthetic Index. Iowa City: College of Dentistry, University of Iowa, 1986.
5. Onyeaso, C. O. and Aderinokun, G. A. The relationship between dental aesthetic index (DAI) and perceptions of aesthetics, function and speech amongst secondary school children in Ibadan, Nigeria. *Int. J. Paed. Dent.* 2003; **13**: 336–341.
6. Otuyemi, O. D., Oguyinka, A., Dosumu, O., *et al.* Perceptions of dental aesthetics in the United States and Nigeria. *Community Dent. Oral. Epidemiol.* 1998; **26**: 418-420.
7. Ng'anga', R. N. and Ng'ang'a, P. M. Hypodontia of permanent teeth in a Kenyan population. *East Afri. Med. J.* 2001; **78**: 200-203.
8. Ng'ang'a, P. M., Karongo, P. K., Chindia, M. L., and Valderhaug, J. Dental caries, malocclusion and fractured incisors in children from a pastoral community in Kenya. *East Afr. Med. J.* 1993; **70**: 175-178.
9. Ng'ang'a, P. M., Ohito, F., Ogaard, B. and Valderhaug, J. The prevalence of malocclusion in 13-15 year old children in Nairobi, Kenya. *Acta. Odontol. Scand.* 1996; **54**: 126-130.
10. Otuyemi, O., Ogunyinka, A., Dosumu, O., *et al.* 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.
11. Rwakatema, D. S., Ng'ang'a, P. M. and Kemoli, A. M. Prevalence of malocclusion among 12-15 year olds in Moshi, Tanzania. *East Afr. Med. J.* 2006; **83**: 372-379.
12. van Wyk, P. J. and Drummond, R. J. Orthodontic status and treatment need of 12-15-year-old children in South Africa using the Dental Aesthetic Index. *SADJ.* 2005; **60**: 334-338.
13. Gábris, K., Márton, S. and Madléna, M. Prevalence of malocclusions in Hungarian adolescents. *Eur. J. Orthod.* 2008; **6**: 467–470.
14. Otuyemi, O. D., Ogunyinka, A., Dosumu, O., *et al.* Perceptions of dental aesthetics in the United States and Nigeria. *Community Dent. Oral. Epidemiol.* 1998; **26**: 418-420.
15. Bernabe', E. and Flores-Mir, C. Orthodontic treatment need in Peruvian young adults evaluated through Dental Aesthetic Index. *Angle Orthod.* 2006; **76**: 417-421.
16. Moyers, R. E. Handbook of orthodontics, 4th edition. Chicago: Year Book Medical Pub; 1988.
17. Jenny, J. and Cons, N. C. Establishing malocclusion

severity levels on the Dental Aesthetic Index (DAI) scale. *Aust. Dent. J.* 1994; **41**: 43-46.

18. Rwakatema, D. S., Ng'ang'a, P. M. and Kemoli, A. M. Orthodontic treatment needs among 12-15 year olds in Moshi, Tanzania. *East Afr. Med. J.* 2007; **84**: 226-232.

19. Katoh, Y., Ansai, T., Takehara, T., Yamashita, Y., *et al*. A Comparison of DAI scores and characteristics of occlusal traits in three ethnic groups of Asian origin. *Int. Dent. J.* 1998; **48**: 405-411.