R. M. Ariemba, BDS, Tutorial Fellow, Department of Conservative and Prosthetic Dentistry, University of Nairobi Dental
Hospital and Post-graduate student, School of Dental Sciences, University of Nairobi. P.O Box 19676-00202, Nairobi, S.
W. Maina, BDS, MDS Senior Lecturer, Department of Conservative and Prosthetic Dentistry, School of Dental Sciences,
University of Nairobi and L.W. Gathece, BDS, MDS, MPH, Associate Professor, Department of Periodontology, Community
and Preventive Dentistry, School of Dental Sciences, University of Nairobi

Request for reprints to: Dr. R. M. Ariemba, Department of Conservative and Prosthetic Dentistry, University of Nairobi,
P.O Box 19676-00202, Nairobi

USE OF NASAL WIDTH TO ESTIMATE THE MESIO-DISTAL WIDTHS OF MAXILLARY ANTERIOR TEETH IN A KENYAN POPULATION OF AFRICAN DESCENT

R. M. ARIEMBA, S. W. MAINA and L.W. GATHECE

ABSTRACT

Objective: To investigate the relationship between the nasal width and the mesio-distal
widths of the maxillary anterior teeth in Kenyans of African descent.
Study design: Descriptive cross-sectional study
Setting: College of Health Sciences, University of Nairobi, Kenya.
Subjects: One hundred and forty six undergraduate and postgraduate students aged
18-30 years were recruited into the study.
Results: Out of the 146 participants, 78 (53.4%) were males and the rest were females.
The overall mean nasal width was 39.54 ± 3.61mm with males having significantly higher
mean values compared to females (41.37 ± 3.04mm and 37.45 ± 3.05mm respectively),
($t=7.75$, $p<0.05$). The mean of the combined mesio-distal width of the anterior teeth
(CMDWAT) was 47.68 ± 2.55mm with males having significantly higher mean values
(48.12 ± 2.49mm) compared to the females (47.16 ± 2.55mm), ($t=2.30$, $p<0.05$). A statistically
significant but weak positive correlation was found between the NW and CMDWAT
($r=0.26$, $r2=0.07$, $p<0.05$).
Conclusion: The results suggest a very weak positive correlation between NW and
CMDWAT and NW was reliable in estimating the CMDWAT in only 7% of the
population. Therefore, NW may not be a reliable guide when used to estimate the
CMDWAT in the population studied.

INTRODUCTION

Complete edentulism is a worldwide condition that is mainly attributed but not limited to tooth extractions as a result of dental caries and periodontal disease. The average total edentulous rate around the world is reported to be 60% at the age of 60 years with a wide disparity among different populations in different countries (1, 2). Loss of teeth leads to atrophy of the supporting alveolar tissues, loss of support for the facial musculature and decreased masticatory efficiency leading to the effects on the quality of life of the edentulous patient (3-5). The oral rehabilitation of the edentulous patient is usually achieved through the fabrication of conventional complete dentures, implant supported complete dentures or implant supported bridges (3, 4). Regardless of the type of prosthesis fabricated, patient acceptance and overall

need to restore the natural appearance of the patient which is partly achieved through appropriate anterior tooth selection which includes the right size, shape and shade (4).

The availability of pre-extraction records including dental casts, facial photographs and dental radiographs makes the process of artificial anterior tooth selection easier. However, absence of these records as is the case with a vast majority of patients can make the process of selecting appropriate sizes of anterior teeth challenging for the clinician. In order to provide dentures that are aesthetically acceptable and enhance patient satisfaction with these prostheses, reliable methods for anterior tooth size selection are required. At present there is no single objective and reliable method of selecting the size of artificial anterior teeth for complete denture patients (5-10).

that has been investigated and suggested for use as a guide when selecting the size of artificial maxillary anterior teeth for the complete denture patient (11-22). This is a measurement taken at the widest points of the ala of the nose. Hoffman et al (14) reported a weak positive correlation between NW and mesio-distal widths of the anterior teeth (MDWAT) measured on a curve between the distal surfaces of the maxillary canines but found a moderate positive correlation between the two measurements when the MDWAT was measured on a curve between the cusp tips of the canines. Yet another study among four different racial groups reported a weak positive correlation between NW and MDWAT measured on a curve between the cusp tips of the canines (17).

Studies by Gomes *et al* (18, 19) among Brazilian populations have reported that when the nasal width is multiplied by 31%, it can give an estimate of the CMDWAT measured along the circumference of the arch between the distal aspects of the canines. Moreover, a different study among the same population concluded that NW is a reliable guide in estimating the CMDWAT (22). Another study by Isa et al among two ethnic groups namely the Chinese and Malay reported that the mesio-distal width of the maxillary lateral incisors and canines were strongly correlated with a combination of interpupillary distance (IPD) and NW (20).

However, some authors have reported no significant correlations between nasal width and inter-canine distance measured either on a curve or in a straight line (11, 13, 20) while others have reported weak positive correlations between the NW and CMDWAT only among females when studying both gender (15).

From the above literature search done, there is an apparent paucity of data on the relationship between nasal width and the mesio-distal width of the maxillary anterior teeth among black Africans. Available data has been conducted mainly on Caucasian populations and the results extrapolated to other racial groups yet African populations have been shown to have wider teeth compared to their Caucasian counterparts (23, 24, 25). Data from various studies on the use of nasal width for anterior tooth size selection have also given contradictory results hence justifying the need to carry out this study. Therefore, the aim of this study was to investigate the use of the nasal width in estimating the mesio-distal width of the maxillary anterior teeth in a sample of a Kenyan population of African descent.

MATERIALS AND METHODS

The study was conducted among undergraduate and postgraduate students at the College of Health Sciences, University of Nairobi who are usually

from different parts of Kenya. The participants were aged between 18- 35 years with the following inclusion criteria: intact, unrestored six natural maxillary anterior teeth and including the 1st and 2nd premolars bilaterally; those whose paternal and maternal parents and grandparents were Kenyans of African descent; those with no facial deformities or history of facial surgery; and those with no history of orthodontic treatment.

Those presenting with malformed anterior teeth such as peg shaped lateral incisors and Hutchison's incisors, proximal restorations or artificial crowns on their maxillary anterior teeth, interdental spaces, midline diastema and rotations of the maxillary anterior teeth, fractured maxillary anterior teeth and tooth surface loss involving the maxillary anterior teeth were excluded.

A total of 146 students were selected through stratified random sampling which involved dividing them into three strata based on where they take their classes (School of Dental Sciences, Kenyatta National Hospital Campus and Chiromo Campus). A sampling frame comprising of the students from each of the three stations was then made and a minimun of 48 participants who met the inclusion criteria selected from each station.

Ethical approval to conduct the study had been obtained from the Kenyatta National Hospital and University of Nairobi Ethics and Research Standards Committee (Approval No.P174/6/2010). A written consent was also sought and obtained from the participants.

Measurements of the nasal width were done in a well lit room with the participants seated on an ordinary chair with their head in an upright position. Impressions of the maxillary arch were taken using irreversible hydrocolloid material (Alginoplast fast set, Haraeus Kulzer, Hanau, Germany) on sterile perforated metallic dentate stock trays. The impressions were disinfected by immersion in 1% sodium hypochlorite solution for five minutes, rinsed under tap water and stored in a sealed polythene bag. With the help of a trained dental technologist, the impressions were then poured within 30 minutes in type IV gypsum material (Ultra rock, Kalabhai, Karson Pvt Ltd, Mumbai, India) in the dental laboratory to generate casts. The individual mesio-distal widths of the six maxillary anterior teeth were then taken from the casts once the material had fully set. These were then summed up to obtain the combined mesio-distal widths of the anterior teeth (CMDWAT).All the measurements were taken using an electronic digital caliper (Mossel, USA) that had been calibrated at the Kenya Bureau of Standards (Certificate No.BS/MET/7/3/30/025) prior to data collection.The measurements were recorded to the nearest 0.01mm and repeated twice at intervals of 5

The data collected were analyzed using the Statistical Package for Social Sciences version 13.0 (SPSS Inc, Chicago, Ilinois, USA). Descriptive and analytical statistics (independent sample t-test, correlation analysis and linear regression analysis) were carried out. The confidence level for this study was 95% and the p-value for statistical significance was set at less than 0.05.

Prior to data collection, the principal investigator was calibrated by two supervisors to determine inter-examiner reproducibility in respect to nasal width and mesio-distal width of the six maxillary anterior teeth and intra-class correlation co-efficient (ICC) values of 0.99 (n=15) obtained for both measurements, indicating an almost perfect agreement. For intra-examiner reproducibility, repeated measurements of every tenth participant and cast were taken (ICC values obtained; 0.97 for NW and 0.98 for the MDWAT). This showed an almost perfect agreement.

RESULTS

Socio-demographic characteristics: Of the 146 participants, 78 (53.4%) were males while 68 (46.6%) were females ranging in between 18-30 years with a mean age of 22.35 ± 2.65 years. The overall modal age was 22 years while the mean age for the males was higher than that of the females (22.82 ± 2.66 SD and 21.81 ± 2.55 SD respectively). There were more females than males in the age group 18-20 years and 21-23 years. On the other hand, there were more males in age groups 24-27 years and 28-30 years (Figure 1).

Nasal width: The mean nasal width was 39.54 ± 3.61mm with a range of 30.95 - 49.05mm. Males had a higher mean nasal width (41.37 ± 3.04mm) compared to the females (37.45 ± 3.05mm) and differences were statistically significant (t=7.75, p=.00) (Figure 2).

Mesio-distal width of maxillary anterior teeth: The combined mesio-distal width of the maxillary anterior teeth (CMDWAT) ranged between 39.47 - 54.72mm with a mean value of 47.68 ± 2.55mm. Males had a

higher mean CMDWAT compared to the females (48.12 ± 2.49mm and 47.16 ± 2.55mm respectively) and the difference was statistically significant (t=2.30, p=0.02). Overall, males had higher mean values for all the teeth compared to females but the differences in the scores between the two groups were statistically significant only for the canine teeth (t=4.49,3.86, p=0.00) (Table 1). In addition, males had higher mean CMDWAT values compared to females for all the age groups (Figure 3).

Correlation between nasal width and mesio-distal width of maxillary anterior teeth: There was a statistically significant weak positive correlation between the nasal width and CMDWAT (r^2=0.07, p=0.00). In terms of the individual mesio-distal tooth widths, only the canines displayed a statistically significant weak positive correlation with the nasal width (r^2=0.12, 0.10, p=0.00) while the central and lateral incisors did not (Table 2).

Multiple linear regression analysis was used to evaluate the association between the nasal and combined mesio-distal widths of anterior teeth after controlling for age and gender. The model used was

$y = \beta_0 + \beta x + \varepsilon$

Where,

y- is the actual change in combined mesio-distal width of anterior teeth in mm

β_0-is the intercept (the value of y when x=0)

β-is the slope of the line (amount by which y changes for each unit change in x)

x- is the nasal width in mm

ε - represents other factors that may influence the dependent variable

The regression analysis yielded a coefficient of determination (r^2) of 0.07 which refers to the amount of variation explained by the independent variable. Therefore, only 7% of the variation in change in the combined mesio-distal width of the anterior teeth can be explained by the nasal width which was also found to be a significant predictor of the change in combined mesio-distal width of anterior teeth (t=-2.53, p=0.01) (Table 3).

Table 1

A comparison of the mean mesio-distal widths of the maxillary anterior teeth by gender

Tooth type	Overall mean widths (mm)	Mean width for the males (mm)	Mean width for the females (mm)	t test	P value (α=0.05)
Right canine	7.91	8.06	7.74	4.49	0.00*
Right lateral incisor	7.10	7.12	7.09	0.35	0.73
Right central incisor	8.80	8.95	8.80	1.63	0.11
Left central incisor	8.87	8.94	8.78	1.72	0.09
Left lateral incisor	7.10	7.14	7.06	0.82	0.41
Left canine	7.88	8.01	7.72	3.86	0.00*
Combined mesio -distal width	47.68	48.12	47.16	2.30	0.02*

*Statistically significant

Table 2

Correlation between the nasal width and mesio-distal widths of the anterior teeth

| Tooth type	r	r²	P value (α=0.05)
Right canine	0.34	0.12	0.00*
Right lateral incisor	0.13	0.02	0.11
Right central incisor	0.16	0.03	0.05
Left central incisor	0.16	0.03	0.06
Left lateral incisor	0.13	0.02	0.14
Left canine	0.31	0.10	0.00*
Combined mesio-distal width	0.26	0.07	0.00*

*Statistically significant

Table 3

Linear regression analysis to show the relationship between the nasal width and the combined mesio-distal width of the anterior teeth
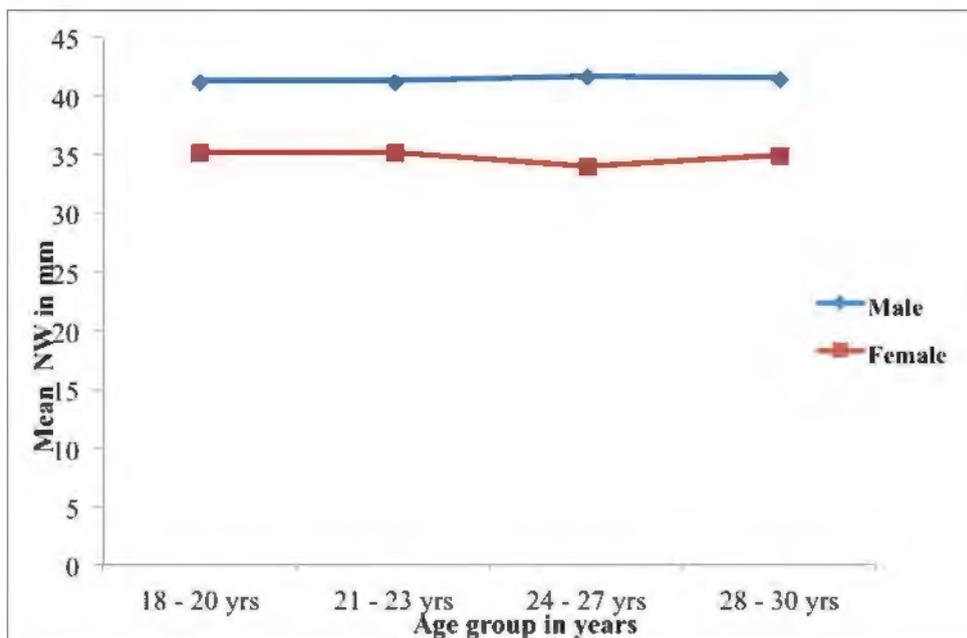
| Variable	B	t value	95% CI Lower Upper	P value (α=0.05)
Nasal width	0.17	2.53	0.04 0.30	0.01*
Gender	-0.45	-0.93	-1.42 0.51	0.35
Age	-0.16	-2.01	-0.31 0.00	0.05
Constant	45.14	12.96	38.26 52.03	0.00

*Statistically significant

Figure 1
Age and gender distribution of the participants
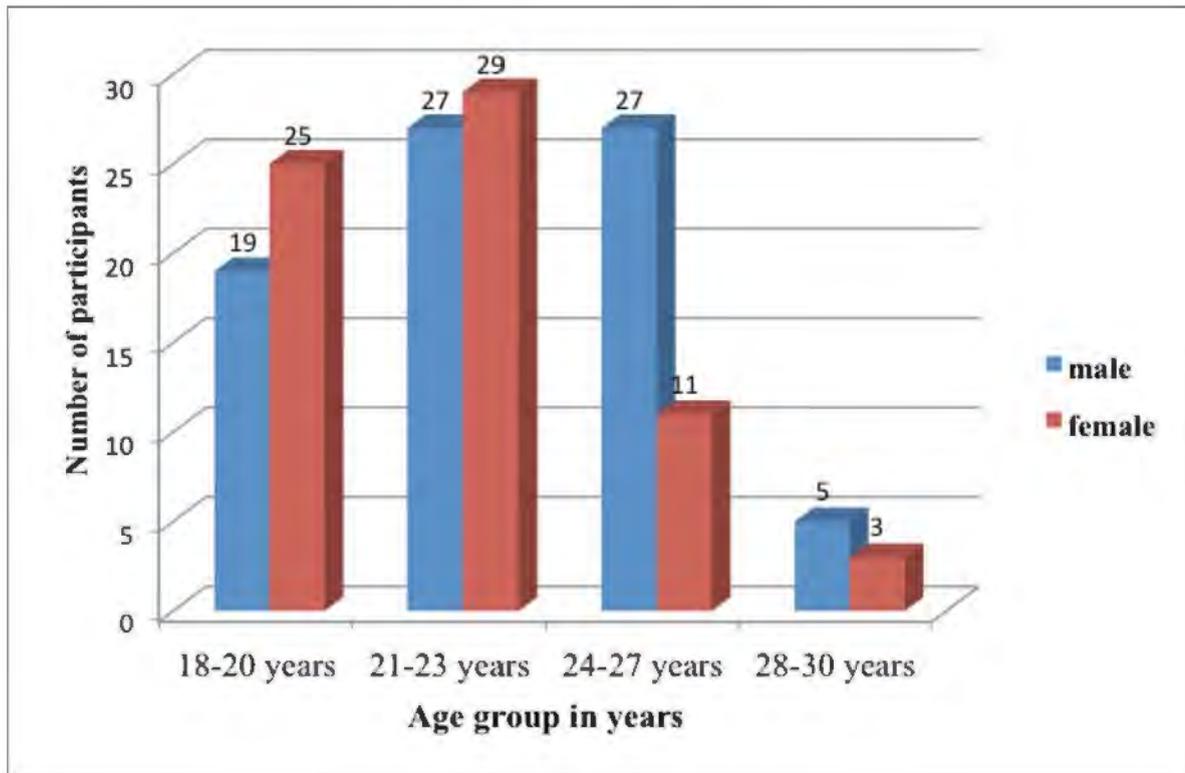
Figure 2
Pattern of the mean nasal width of the participants by age group

Figure 3
Mean combined mesio-distal width of the anterior teeth by gender and age
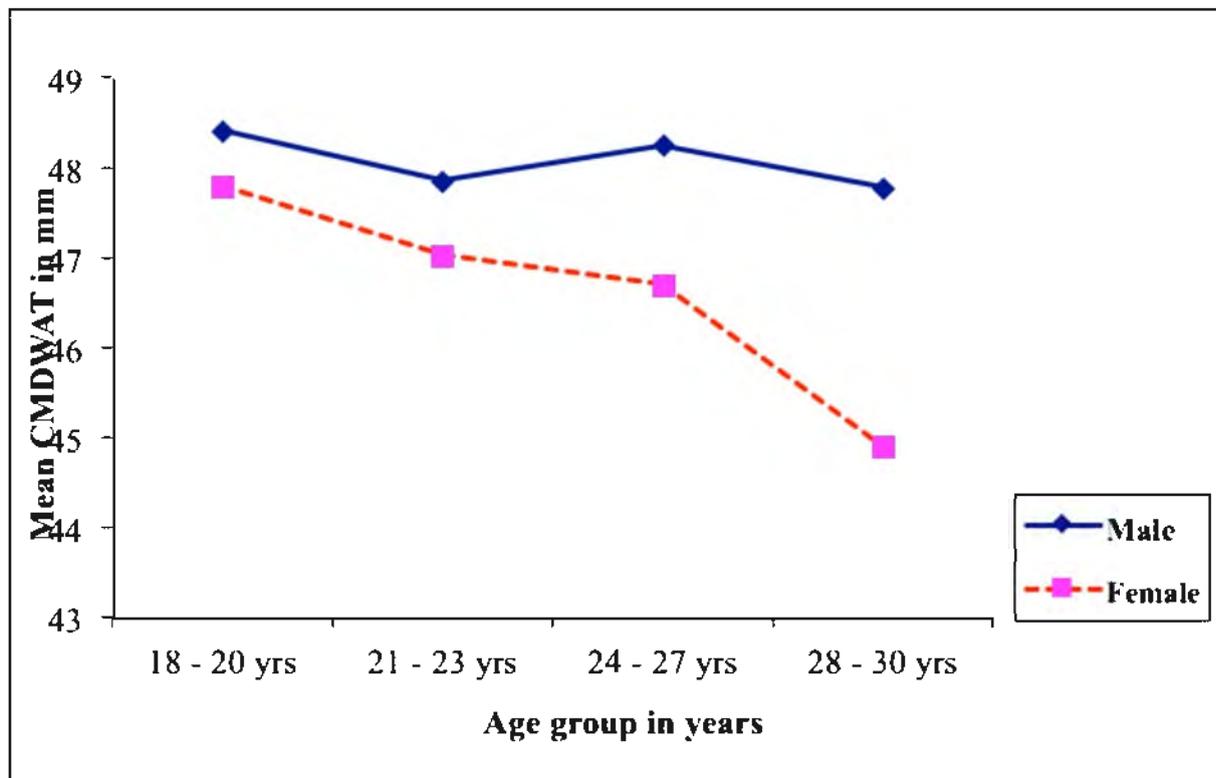
DISCUSSION

Nasal width (inter-alar width) is one of the anthropometric measurements that has been investigated as a guide in estimating the mesio-distal width of anterior teeth for the completely edentulous patient lacking pre extraction records. The mean nasal width for the present study (39.54 ± 3.61) is comparable to that reported by two studies (18, 20) where the authors reported a mean nasal width of 39.36 ± 3.12mm. However, studies among other Caucasian populations have reported lower mean nasal widths compared to the current study (12,14,21) while a study among a Brazilian population (17) reported a higher mean nasal width compared to the present study (42.39mm). These differences in the mean values could be attributed to racial differences with Caucasian populations having a long and narrow nose compared to African populations (13). Variability in measuring techniques with some authors having taken the measurements from facial photographs analyzed using an image analyzing software (19, 21) as opposed to direct clinical measurements using digital calipers could also explain the differences. The different instruments used in taking the measurements such as the vernier caliper, Willis gauge (12) or Boley gauge (14) could also lead to variation in the mean values obtained since

The current study also reported a higher mean nasal width for males compared to the females which is in agreement with data from other studies (13,15,17-19) a finding that could be attributed to sexual dimorphism with males having been found to have larger facial features compared to their female counterparts.

Studies among Caucasian populations have reported mean combined mesio-distal widths of the maxillary anterior tooth values ranging between 42.16mm and 60.33mm (6,14,18-20,22,23).The current study reported a mean combined mesio-distal width of the maxillary anterior teeth (MDWAT) that was within a range reported by previous researchers. The different techniques used in measuring the mesio-distal width of the maxillary anterior teeth could have yielded the wide disparity in the results obtained. Clinical measurements taken directly in the mouth may not be as accurate as when the measurements are taken from casts since there may be interference from the oral structures such as the lips and the tongue (26). The researcher may also not have a chance of recalling the participants to repeat the measurements incase of errors whereby measurements obtained are far apart unlike casts that can easily be accessed for repeat measurements.

The type of gypsum product used to generate casts for the mesio-distal tooth width measurements may also have contributed to variation in the average

gypsum used for the current study is superior to that of type III (27). Therefore measurements taken from casts generated from the former material are likely to be more accurate compared to those measured from the latter since there is less likelihood of loss of tooth structure from the casts from type IV gypsum due to its high abrasion resistance. Instruments used in carrying out the measurements such as a piece of string which is then transferred to a ruler, use of a vernier caliper, digital caliper, flexible ruler or taking the measurements from a photograph through an image processing software could also explain the differences observed. The actual measurement of the mesio-distal dimensions of the six maxillary anterior teeth also varied between different researchers with some measuring the distance on a curve between the distal aspects of the two maxillary canines at the contact points. Others undertook the measurements on a curvature between the cusp tips of the two canine while yet another group employed a technique used in the current study whereby the mesio-distal widths of the six maxillary anterior teeth were taken individually and then summed up to obtain the combined mesio-distal widths. In addition, racial differences in the mesio distal tooth widths have also been reported in literature with African populations having been found to have wider teeth compared to their Caucasian counterparts (25).

Males had a higher mean CMDWAT compared to the females, a finding that is consistent with reports from other studies conducted among different populations (13, 15, 18,19). In addition, the current study found statistically significant gender differences in the mesio-distal widths of the canines, a finding that has been reported from studies conducted among Caucasian populations (26).

The relationship between the nasal width and the combined mesio-distal width of the maxillary anterior teeth was also investigated. The present study reported a statistically significant weak positive correlation between the nasal width and the width of the canines and the nasal width and combined mesio-distal width of the maxillary anterior teeth in 7% and 10% of the population studied (r^2=0.07 and r^2=0.10 respectively). These findings are comparable to reports by other authors (14). However, this only represents a small proportion of the population with more than 90% of the population studied not accounted for.

In conclusion, based on the findings of this study, it can be concluded that there were statistically significant differences in mean values for the nasal width and the combined mesio-distal width of the maxillary anterior teeth among the males and females. There was a weak positive correlation between the nasal width and the combined mesio-distal widths

predicting the mesio-distal width of the six maxillary anterior teeth in only 7% of the population studied. Therefore, this facial measurement may not be used as reliable guide in predicting the mesio-distal width of the six maxillary anterior teeth for a vast majority of the Kenyan population of African descent studied.

ACKNOWLEDGEMENTS

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