RELATIONSHIP BETWEEN THE NASAL, INNER-CANTHAL AND MESIO-DISTAL WIDTHS OF THE MAXILLARY ANTERIOR TEETH IN A KENYAN POPULATION

RAEL MORAA ARIEMBA (BDS., Nbi), V60/76508/2009

DEPARTMENT OF CONSERVATIVE AND PROSTHETIC DENTISTRY, SCHOOL OF DENTAL SCIENCES, COLLEGE OF HEALTH SCIENCES, UNIVERSITY OF NAIROBI

THESIS SUBMITTED IN PARTIAL FULFILLMENT FOR THE AWARD OF MASTER'S OF DENTAL SURGERY (MDS) DEGREE IN PROSTHODONTICS, DEPARTMENT OF CONSERVATIVE AND PROSTHETIC DENTISTRY, SCHOOL OF DENTAL SCIENCES, UNIVERSITY OF NAIROBI

OCTOBER 2014

DECLARATION

This thesis is my original work and has not been presented for a degree in any other university

Rael Moraa Ariemba, BDS., (Nbi)

Sign _____Date_____

SUPERVISORS APPROVAL

This thesis has been submitted with our approval as University of Nairobi supervisors;

Dr. Edwin W. Kibugi, BDS. (Nbi), MSC. (UK).
Department of Conservative and Prosthetic Dentistry, School of Dental Sciences, University of Nairobi.

Sign _____ Date _____

Dr. Susan W. Maina, BDS., (Nbi), MSc, AEGD and Aesthetic Dentistry (USA), OGW.
Department of Conservative and Prosthetic Dentistry, School of Dental Sciences, University of Nairobi.

Sign _____ Date _____

Professor Loice W. Gathece, BDS., MPH., PhD. (Nbi).
Department of Periodontology, Community and Preventive Dentistry, School of Dental Sciences, University of Nairobi.

Sign _____ Date _____

DEDICATION

This work is dedicated to my husband Charles Ngige and my daughter Natalie Anaya.

ACKNOWLEDGEMENTS

First and foremost, I thank God for keeping me strong and healthy throughout the duration of my studies. My sincere gratitude goes to my supervisors; Professor Loice Gathece, Dr. Edwin Kibugi and Dr. Susan Maina for their constant guidance, support and encouragement.

Many thanks go to my assistants Josephat Miyogo and Stella Bosire for their contribution during data collection. My appreciation also goes to Dr Edwin Kagereki for assisting with the data entry and analysis.

I am grateful to the Ministry of Medical Services and the University of Nairobi for granting me study leave and for sponsorship that enabled me pursue my postgraduate studies.

I would like to acknowledge all the students who participated in this study.

Finally, I wish to thank my husband Charles Ngige without whose support I would not have had the courage and perseverance to the very end and for his patience and tolerance during the course of my studies.

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ACRONYMS

CMDWAT	Combined mesio-distal width of anterior teeth
ICD	Inter-canine distance
ICM	Inter-commissural width
ICW	Inner-canthal width
IPD	Inter-pupillary distance
KNH	Kenyatta National Hospital
LC	Left canine
LCI	Left central incisor
LLI	Left lateral incisor
MD	Mesio-distal
MDWAT	Mesio-distal width of anterior teeth
NW	Nasal width
PI	Principal investigator
RC	Right canine
RCI	Right central incisor
RLI	Right lateral incisor
SDS	School of Dental Sciences
UON	University of Nairobi

DEFINITION OF TERMS

Edentulous:	Without teeth, lacking teeth
Edentulism:	The state of being edentulous; without natural teeth
Inner canthal width:	The distance between the medial angles of the palpebral fissures of the eyes
Mesio-distal width:	The greatest distance between the contact points of a tooth
Nasal width:	The width measured at the widest points of the ala of the nose

ABSTRACT

Background: Edentulism is a worldwide condition that necessitates oral rehabilitation of the edentulous patient through fabrication of conventional complete dentures, implant supported removable complete dentures or implant retained bridges. A natural appearance of complete dentures is partly achieved through selection of appropriate moulds of artificial anterior teeth. Absence of pre-extraction records can, however, make the process of anterior tooth selection challenging for clinicians leading to patients being dissatisfied with the prostheses. Although a number of studies have investigated the use of facial measurements as a method of calculating anterior tooth widths, the results have been contradictory. Furthermore, there is also the paucity of data regarding the use of facial measurements for anterior tooth selection among African populations.

Objective: To evaluate the reliability of the nasal and inner canthal widths in estimating the mesio-distal widths of the maxillary anterior teeth in a Kenyan population.

Study design: This was a descriptive cross-sectional study

Material and Method: One hundred and forty six undergraduate and postgraduate students aged 18-30 years from the Schools of Pharmacy, Nursing, Medicine and Dental Sciences, College of Health Sciences, University of Nairobi were recruited into the study. The students were selected through stratified random sampling. Data on nasal and inner canthal width were obtained through direct measurements while that of mesio-distal widths of the maxillary anterior teeth were obtained from type IV gypsum product casts (Ultra rock,Kalabhai,Karson Pvt Ltd,Mumbai,India) generated from irreversible hydrocolloid impressions of the maxillary arch (Alginoplast,Haraeus Kulzer,

Hanau,Germany). An electronic digital caliper was used to obtain the measurements which were then entered onto a data capturing form. The data obtained were analyzed using the Statistical Package for Social Sciences version 13.0 (SPSS Inc, Chicago, Ilinois, USA).

Results: Out of the 146 participants, 78 (53.4%) were males while 68 (46.6%) were females. The mean age was 22.35 ± 2.65 years. The overall mean nasal width was 39.54 ± 3.61mm with males having had significantly higher mean values compared to females (41.37 ± 3.04mm and 37.45 ± 3.05mm respectively), ($t=7.75$, $p<0.05$). The overall mean inner canthal width was 34.27 ± 2.68mm with the mean inner canthal width for males (34.73 ± 2.69mm) having been higher than that of the females (33.74 ± 2.58mm), ($t=2.27$, $p<0.05$). The mean of the combined mesio-distal width of the anterior teeth (CMDWAT) was 47.68 ± 2.55mm with males having had 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 weak positive correlation was found between the nasal width, inner canthal width and CMDWAT ($r=0.26$, $r^2=0.07$, $p<0.05$ and $r=0.17$, $r^2=0.03$, $p<0.05$ respectively).

Conclusion: For the population studied, the nasal width could be used to estimate the mesio-distal width of the maxillary anterior teeth in 7% of the population while the inner canthal width could be used in 3% of the population. Therefore, for the population studied, the two facial measurements cannot be used as reliable guides in estimating the mesio-distal widths of the maxillary anterior teeth.

Recommendations: There is need to put emphasis on the importance of pre- extraction records in order to ease anterior tooth selection during complete denture fabrication. Further research also needs to be carried out in a larger sample of the population so as to allow for more reliable extrapolation of the results to the general population.

CHAPTER 1

1.0: INTRODUCTION AND LITERATURE REVIEW

1.1 Introduction

Edentulism is a condition that affects every race worldwide. It is mainly attributed but not limited to extractions as a result of two major oral ailments namely dental caries and periodontal disease. The average total edentulous rate around the world is reported to be 60% at the age of 60 years, although there is 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. This, in turn, affects the quality of life of the edentulous patient. Oral rehabilitation of these patients 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 satisfaction is paramount. To achieve this, there is 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]. Availability of pre-extraction records including dental casts, facial photographs and dental radiographs makes the process of artificial anterior tooth selection easier. However, the absence of these records can make the process challenging for the clinician since there is lack of a single objective and reliable method of selecting artificial anterior teeth for the edentulous patient [5, 6, 7, 8, 9, 10].

Maxillary anterior tooth widths for complete denture patients have been investigated using various facial measurements[11-29, 35]. However results from several studies have

given contradictory results while others have reported no significant correlations[12, 14, 15, 18, 19, 24]. In addition, most of the studies have been carried out among Caucasian populations and information on African populations is scarce.

Therefore, the aim of this study was to determine the nasal width, inner canthal width and the mesio-distal widths of the maxillary anterior teeth in a Kenyan population of African descent. The study also investigated the relationship between the nasal width, inner canthal width and the mesio-distal width of the maxillary anterior teeth.

1.2: Literature Review

Edentulism remains a worldwide condition that is mainly attributed to dental caries and periodontal disease. It usually leads to local anatomical changes and psychological changes that include continued residual ridge resorption, reduced masticatory function, altered facial aesthetics as well as deterioration in social functions. Affected individuals can be managed through fabrication of conventional complete dentures, implant supported removable dentures or implant supported bridges. Regardless of the type of prosthesis fabricated for the edentulous patient, there is the need to restore the natural appearance of the patient. This is partly achieved through appropriate anterior tooth size selection[5, 7]. The procedure of anterior tooth size selection can be challenging for the clinician due to the unavailability of pre-extraction records.

Various methods have been used to select anterior teeth for the edentulous patient with the history dating back to the 19th century when Leone Williams[3, 4, 30, 31] tried to relate facial types and tooth forms. He classified facial types into ovoid, tapering and square and it was assumed that the shape of the upper central incisors bore a direct relationship with the shape of the face. This system does not consider the size of anterior teeth and,

therefore, when used alone it does not give the clinician any idea on the approximate sizes of anterior teeth for the edentulous patient. Another concept reported by Frush and Fisher relates the shape of the anterior teeth with the patient's age, gender and personality[32]. The authors of this theory suggested various alterations of tooth shape and position according to an individual's characteristics. Feminine attributes in the tooth moulds were characterized by gentle rounded features while masculine features signified robust cuboidal forms. Both theories are only helpful when selecting the shape of the anterior teeth for the edentulous patient without regard for the size of these teeth. The relationship between various facial measurements and the natural maxillary anterior teeth has been evaluated and suggested for use during anterior tooth selection for the edentulous patient[11, 12, 14-28, 33, 37]. Some of these facial measurements include; bizygomatic width, inter-pupillary distance (IPD), inter-pterygomaxillary notch distance, inter-commissural width (ICM), nasal width (NW) and inner canthal width (ICW).

The inter-pupillary distance which is measured from the mid-pupil to mid-pupil of the eyes on frontal views of facial photographs has been suggested as a guide in estimating the width of the anterior teeth [11, 12, 14, 29, 36]. A study investigating the relationship between the IPD and the mesio-distal width of the maxillary central incisor reported a ratio of IPD to mesio-distal width of the maxillary central incisor of between 6.5 and 7.0. This study concluded that IPD could be used reliably in selecting the MD width of the maxillary central incisor[11]. In another study among adults of Chinese and Malay ethnicity, the mean IPD was 62.28mm and a combined MD width of the six maxillary anterior teeth of 47.14mm. The authors also reported a strong correlation between the widths of the lateral incisors and canines and a combination of IPD and nasal width. Results from this study

led to the conclusion that the IPD could be used as a guide for selecting MD widths of the anterior teeth. A study among a Brazilian population[14] reported IPD values ranging between 57.90 - 79.89mm. However, for the same population, a weak positive correlation was reported between the IPD and CMDWAT measured on casts.

Determination of the IPD requires the clinician to take standardized full face digital images of the patients from the frontal aspect and then loading them to an image analyzing software to determine the inter-pupillary distance in order to obtain an accurate measurement[12, 14].

Use of the inter-pterygomaxillary notch distance**;** a palpable notch formed by the junction of the maxilla and the pterygoid hamulus of the sphenoid bone has been suggested. A study among Turkish dental students reported a mean inter-pterygomaxillary notch distance of 42.38mm measured on dental stone casts and a combined MD width of the maxillary anterior teeth of 46.02mm[13]. However, the authors found a weak relationship between the two measurements and concluded that this parameter could not be used during anterior tooth size selection.

Inter-commissural width measured along the maxillary lip vermillion between the points at the corners of the mouth has also been evaluated. A study in a Brazilian population reported a strong positive correlation between the ICM and MD widths of the maxillary anterior teeth measured on dental casts[14]. Other studies have reported a weak positive correlation between the ICM and inter-canine distance measured on dental casts and concluded that this parameter is inaccurate when used for anterior tooth selection[15, 33].

Nasal width (NW) also referred to as inter-alar width by some authors is a facial measurement taken at the widest points of the ala of the nose. It has been reported that this width can be used as a guide when selecting maxillary anterior teeth for complete denture patients. Studies among Brazilians have reported that when the nasal width is multiplied by a factor of 1.3, it can give an estimate of the combined mesio-distal width of the maxillary anterior teeth along the circumference of the arch between the tips of the maxillary canines[14, 16]. A study among a Brazilian population representing two ethnic groups namely the Chinese and Malay reported that the mesio-distal width of the maxillary lateral incisors and canines where highly correlated with a combination of IPD and NW[12].

Another study demonstrated a strong relationship between the NW and the inter-canine width measured between the cusp tips and a weak relationship when the NW was plotted against the circumferential arc distance from the distal surface to distal surface of the maxillary canines[17]. However, some authors have not reported any significant relationship between nasal width and inter-canine distance measured either on a curve or in a straight line[18, 19, 23, 25].

The inner canthal width also referred to as the inter-canthal width is the distance between the medial angles of the palpebral fissures of the eyes. This facial measurement has been shown to remain relatively stable by the age of 8-11 years and by 18 years of age it is usually 96.5 % and 99.1% developed in females and males respectively[39]. Studies evaluating the relationship between the ICW and the mesio-distal width of the maxillary anterior teeth measured on dental casts reported a weak positive correlation between the ICW and the combined mesio-distal width of the six maxillary anterior teeth measured on

dental casts[20, 29]. However, results from other studies have led to the conclusion that the ICW can be used as a reliable guide for the estimation of the MD width of the maxillary anterior teeth[22, 24, 35] while some have reported in-conclusive results[12, 14].

In conclusion, edentulism is a worldwide condition that affects the quality of life of the affected patient. Oral rehabilitation of the affected individual necessitates fabrication of removable or fixed complete dentures. In order to enhance patient acceptance and overall satisfaction, it is important to select the right size of the anterior teeth for the prostheses. The absence of pre-extraction records can make the process challenging for many clinicians since there is no single reliable method for anterior tooth selection for the edentulous patient. A literature search has revealed paucity of data on this subject among black Africans. Available data has been conducted mainly on Caucasian populations and the results extrapolated to other racial groups. Information on African populations who have been shown to have wider teeth compared to their Caucasian counterparts is scarce[40, 41]. Data from various studies on anterior tooth selection has also given contradictory results.

1.3: Research problem

Successful oral rehabilitation of the edentulous patient is partly achieved through appropriate anterior tooth size selection. In the absence of pre-extraction records as is the case with a vast majority of patients, selection of appropriate sizes of anterior teeth can pose a challenge for the clinician. In order to provide dentures that are aesthetically acceptable and enhance patient satisfaction with these prostheses, reliable methods for anterior tooth selection for complete denture patients are needed.

Although various methods have been evaluated in a bid to come up with reliable guides for anterior tooth selection, there appears to be no single reliable method that is universally accepted. Available data on anterior tooth selection methods has been conducted mainly in Caucasian populations and the results extrapolated to other populations. Data from other studies also gives contradictory results hence the need to carry out this study.

1.4: Justification

Due to the paradigm shift from empirical to evidence based practice, there is need to come up with methods of teaching and practice that can be proven through science. Majority of edentulous patients seeking prosthetic rehabilitation with complete dentures do not have any pre-extraction records due to lack of awareness on the need to keep such records. There is also a tendency for these patients to seek fabrication of complete dentures at facilities other than where they had previous dental treatment done making it difficult to access any pre-extraction dental records.

Since there is no published data on nasal width, inner canthal width and mesio-distal width of anterior teeth in the Kenyan population, the aim of this study was, therefore, to determine the nasal, inner canthal and mesio-distal widths of the maxillary anterior teeth. The study also aimed at establishing whether there is a relationship between the facial measurements and mesio-distal widths of the maxillary anterior teeth which can be used as a guide during anterior tooth selection for the complete denture patient.

1.5: Objectives

1.5.1: Broad objective

The broad objective for this study was to investigate the relationship between nasal, inner canthal and mesio-distal widths of the maxillary anterior teeth in a Kenyan population.

1.5.2: Specific objectives

To achieve the broad objective, the following were the specific objectives;

1. To determine the nasal width in adult dentate Kenyans of African descent.
2. To determine the inner canthal width in adult dentate Kenyans of African descent.
3. To determine the mesio-distal width of the maxillary anterior teeth of Kenyans of African descent.
4. To determine whether there is a relationship between the nasal and mesio-distal widths of the maxillary anterior teeth.
5. To determine whether there is a relationship between the inner canthal and mesio-distal widths of the maxillary anterior teeth

1.6: Hypotheses

1.6.1: Null hypotheses

1. There is no relationship between the nasal width and the mesio-distal widths of the maxillary anterior teeth.
2. There is no relationship between the inner canthal width and the mesio-distal widths of the maxillary anterior teeth.

1.7: Variables

Table 1.1: Study variables

Variable	Measurement
Socio- demographic variables	
Age	Number of years since birth
Gender	Whether male or female
Independent variables	
Nasal width	Average width in mm measured between the ala of the nose at the widest points
Inner canthal width	Average width in mm measured at the medial angles of the palpebral fissures of the eyes
Dependent variable	
Mesio-distal widths of the six maxillary anterior teeth	Average widths in mm measured as the greatest distance between the contact points

CHAPTER 2

2.0 MATERIAL AND METHOD

2.1: Study area

The study was carried out at the Schools of Medicine, Pharmacy, Nursing and Dental Sciences that constitute the College of Health Sciences, University of Nairobi. The College which is located at the Kenyatta National Hospital (KNH) Campus was established in 1985 through an act of parliament and has five Schools, one Institute and one Centre. The Schools of Medicine, Nursing and Pharmacy are situated at the KNH off Ngong' road. The clinical departments for the three Schools are situated at KNH while the pre-clinical departments are housed at the Chiromo Campus. The School of Dental Sciences (SDS) situated off Arwings Kodhek road opposite the Nairobi Hospital has its clinical departments situated at the School while the pre-clinical departments are housed at Chiromo Campus.

2.2: Study design

The current study was a descriptive cross-sectional study.

2.3: Study population

The study population included undergraduate and postgraduate students from four of the Schools that constitute the College of Health Sciences.

2.3.1: Inclusion criteria

1. Individuals aged between 18 years (since they are legally in a position to consent to the study) and 35 years (to avoid ageing alterations such as tooth wear).

2. Individuals who consented to the study.

3. Individuals with intact, unrestored six natural maxillary anterior teeth and including the 1st and 2nd premolars bilaterally.
4. Individuals whose paternal and maternal parents and grandparents were Kenyans of African descent.

2.3.2: Exclusion criteria

1. Individuals with malformed anterior teeth such as peg shaped lateral incisors and Hutchison's incisors.
2. Individuals with proximal restorations or artificial crowns on their maxillary anterior teeth.
3. Individuals with interdental spaces, midline diastema and rotations of the maxillary anterior teeth.
4. Individuals with a history of orthodontic treatment.
5. Individuals with fractured maxillary anterior teeth.
6. Individuals with tooth surface loss involving the maxillary anterior teeth.
7. Individuals with facial deformities or history of facial surgery.

2.4: Sample determination

The sample size was calculated using the Betty Kirkwood Formula (1992)[42].

$n = Z^2.\mu/e^2$

In this formula;

n is the desired sample size.

Z is the standard normal deviate, usually set at 1.96 and corresponds to 95 % confidence level.

μ is the estimated value of an attribute in the target population under study. A mean inner-canthal width in a Nigerian population [43] reported to be 37.27 mm was used as a reasonable estimate for one of the characteristics under study.

e is the maximum size of standard error in the measurement set at 1mm

Therefore;

n =1.96x1.96x37.27/1.

=**143** subjects.

Therefore; the minimum sample size calculated was 143 subjects. However, 146 subjects were involved in this study.

2.5: Sampling procedure

Data were collected from three stations where the undergraduate and postgraduate students from the College of Health Sciences study (School of Dental Sciences, Kenyatta National Hospital Campus and Chiromo Campus). The students were sampled through stratified random sampling whereby they were divided into three strata based on where they take their classes SDS, KNH and Chiromo Campus. A sampling frame comprising of the students from each of the three stations was then made. A minimum of 48 students who met the inclusion criteria were then selected from each of the stations to participate in the study.

2.6: Validity and reliability

Prior to data collection, the accuracy of the electronic digital caliper used to take the relevant measurements was calibrated at the Kenya Bureau of Standards (Certificate No.BS/MET/7/3/30/025). The principal investigator (PI) was calibrated by two

supervisors. Measurements for the nasal, inner canthal and mesio-distal width of the six maxillary anterior teeth were done to determine inter-examiner reproducibility. Intra-class correlation coefficients (ICC) were then calculated and an almost perfect agreement was obtained between the examiners with ICC values ranging between 0.94-0.99 (0.99 for the nasal width, 0.94 for inner canthal width and 0.99 for mesio-distal tooth widths, n=15). For intra-examiner variability, repeated measurements of every tenth participant and cast were taken (ICC values obtained; 0.94 for ICW, 0.97 for NW and 0.98 for MDWAT). This showed an almost perfect agreement.

2.7: Data collection instruments and techniques

Data collection was done in the field in a well lit room with the participants seated on an ordinary chair. All the measurements were taken by the PI. The first stage involved an oral interview to gather information on socio-demographic characteristics. This was then followed by taking measurements for the nasal and inner canthal widths using an electronic digital caliper (Mossel, USA). Maxillary arch impressions were taken using irreversible hydrocolloid impression material (Alginoplast fast set, Haraeus Kulzer, Hanau, Germany) on sterile perforated metallic dentate stock trays. The irreversible hydrocolloid was chosen due to its dimensional stability and ease of manipulation when handled according to the manufacturer's instructions and poured within 30 minutes. The impressions were disinfected by immersion in 1% sodium hypochlorite solution for 5 minutes, rinsed under tap water and stored in a sealed polythene bag. With the help of a trained dental technologist, the impressions were poured within 30 minutes using type IV gypsum product (Ultra rock, Kalabhai, Karson Pvt Ltd, Mumbai, India) in the dental laboratory to generate casts.

In the second stage mesio-distal tooth widths were taken from the casts twice at intervals of 5 minutes and an average value obtained. All the measurements were taken in millimeters and recorded into a data capturing form.

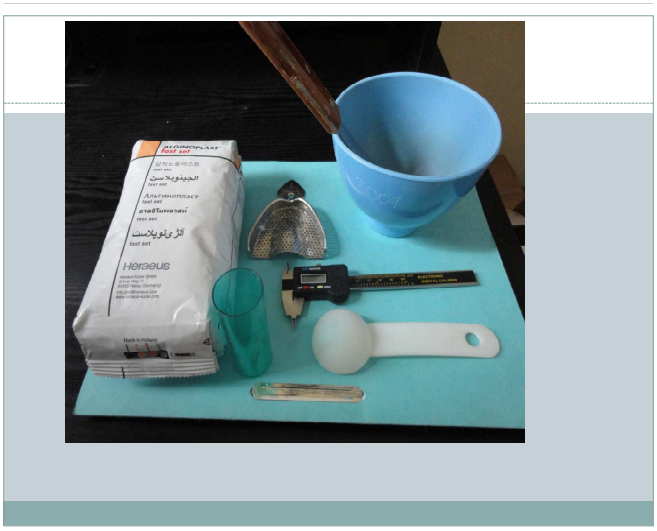

Fig 2.1: Data collection instruments.

2.7.1: Nasal width measurement

The same procedure described and used by previous authors[14, 16, 18, 31]was used in this study. The subjects sat in an upright position with the head supported. With the PI on the subject's right hand side, the digital caliper was placed against the alae of the nose at the widest points and the reading taken. The recording parts of the caliper were brought into contact with the outer surfaces of the ala of the nose under minimal pressure with the instrument just touching the soft tissues. The nasal width was then recorded to the nearest 0.01mm and repeated twice at intervals of 5 minutes to obtain an average value.

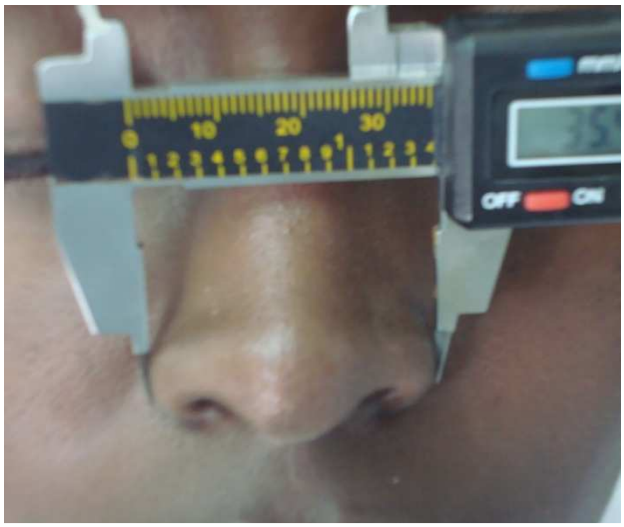

Fig 2.2: Measurement of the nasal width.

2.7.2: Inner canthal width measurement

A procedure described and used by previous authors[20, 21] was used in this study. The subjects were seated in an upright position with the head supported against a wall and their eyes partially closed. The digital caliper was placed against the forehead and lowered towards the eyes and its arms adjusted so that they were in gentle contact with the medial angles of the palpebral fissures of the eyes. The inner canthal width was then recorded to the nearest 0.01mm and repeated twice at intervals of 5 minutes to obtain an average value.

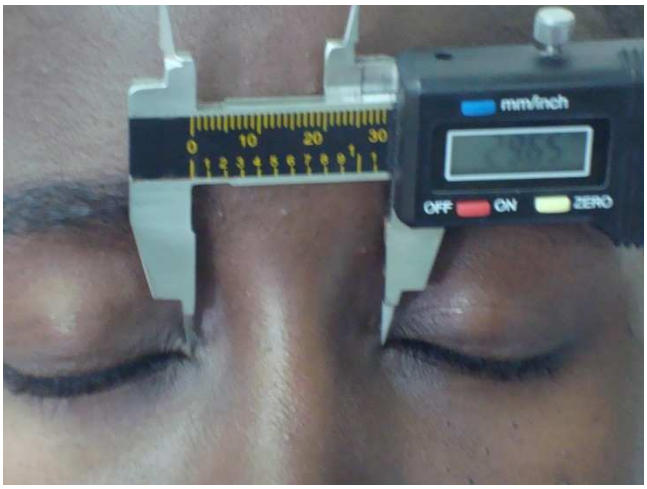

Fig 2.3: Measurement of the inner-canthal width.

2.7.3: Maxillary arch impressions

Impressions were taken using irreversible hydrocolloid (Alginoplast fast set, Haraeus Kulzer, Hanau, Germany) loaded on perforated dentate metalic stock trays. The material was manipulated according to the manufacturer's instructions. The impressions were disinfected by immersion in 1% sodium hypochlorite solution for 5 minutes, rinsed under tap water and stored in sealed polythene bags. With the help of a trained dental technologist, the impressions were poured within 30 minutes using type IV gypsum product (Ultra rock, Kalabhai, Karson Pvt Ltd, Mumbai, India) in the dental laboratory. The die stone was proportioned to the recommended powder to water ratio and mixed using a vacuum mixer for all the impressions.

2.7.4: Tooth width measurements

Mesio-distal widths of the maxillary anterior teeth were taken from casts using an electronic digital**.** The measurement of each tooth crown width was performed using the procedures described by previous authors[34, 41] which defined the mesio-distal widths as the greatest distance between the contact points. The tips of the caliper were placed at the

contact points parallel to the occlusal surface and perpendicular to the long axis of the tooth and care was taken not to abrade the contact points during measurements. All the measurements were recorded to the nearest 0.01mm, repeated twice at intervals of 5 minutes and an average value obtained and entered into a data capturing form.

Fig 2.4: Measurement of the mesio-distal width of the anterior teeth.

2.8: Data analysis and presentation

The data collection forms were assigned numbers. The data collected were then entered into a computer and analyzed using the Statistical Package for Social Sciences version 13.0 (SPSS Inc, Chicago, Ilinois, USA). The parametric statistics were the primary choice for exploring the relationship between the independent variables and the dependent variables because there was normal distribution. The tests used were an independent sample t-test, correlation and linear regression analysis whose model was;

$y = \beta 0 + \beta_1 x + \beta_2 x + \beta_3 x + \varepsilon$ (Appendix IV)

The confidence level for this study was 95% and the p-value for statistical significance was set at less than 0.05.

2.9: Ethical considerations

The proposal for the study was approved by the Ethics, Research and Standards Committee of Kenyatta National Hospital and University of Nairobi (Approval No.P174/6/2010). Permission was granted by the Deans of the Schools where the data collection was done.

The purpose of the study, the expected benefits and risks were explained to the participants and any questions regarding the study were answered appropriately. Before enrolling in the study, written informed consent was obtained from each participant (Appendix I). Each participant meeting the inclusion criteria had an equal chance of being included in the study. Withdrawal privilege was maintained at all times and all information collected was treated confidentially.

During the study period, the participants received dental consultation and oral health education and those requiring dental treatment were referred to the nearest health facility for treatment.

CHAPTER 3

3.0: RESULTS

3.1: Socio-demographic characteristics

Of the 146 students recruited into the study, 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). Notably, the difference was statistically significant (t=2.3, p=0.02). Fig. 3.1 shows the distribution of the age and gender of the participants. 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.

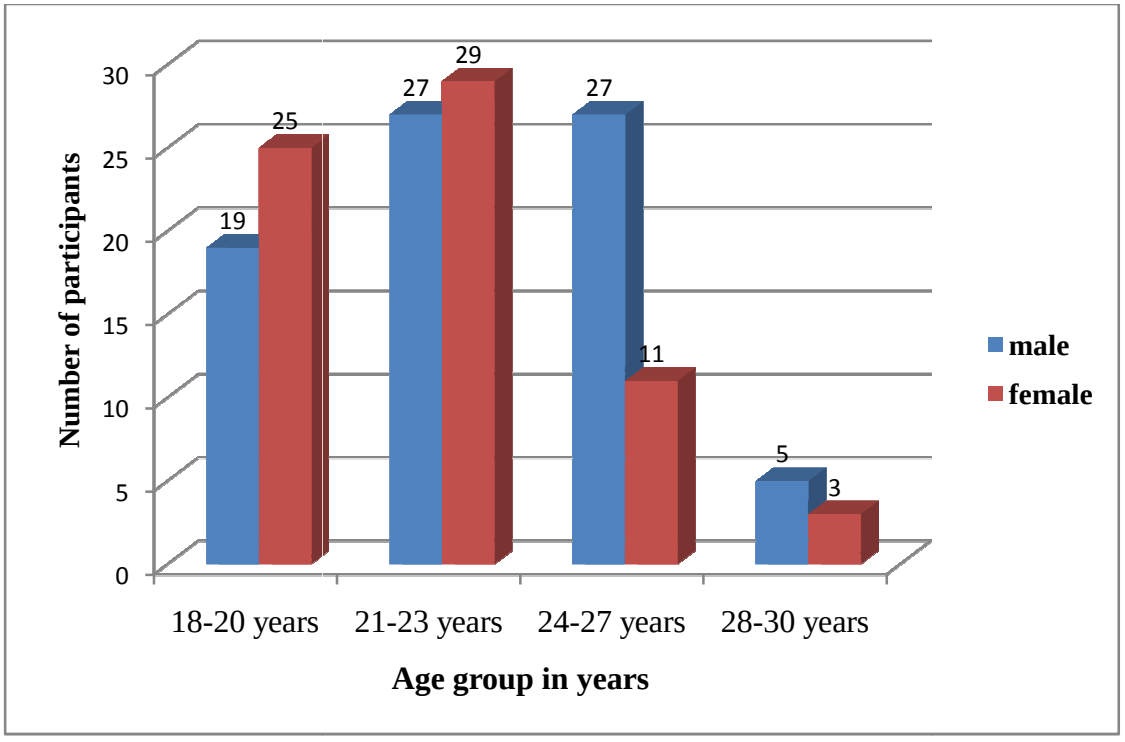

Fig. 3.1: Age and gender distribution of the participants

3.2: 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). There was a weak positive correlation between the nasal width and age (r = 0.19, p=0.03, n=146).

Fig. 3.2 shows the mean values for the nasal width for the males and females for the different age groups.

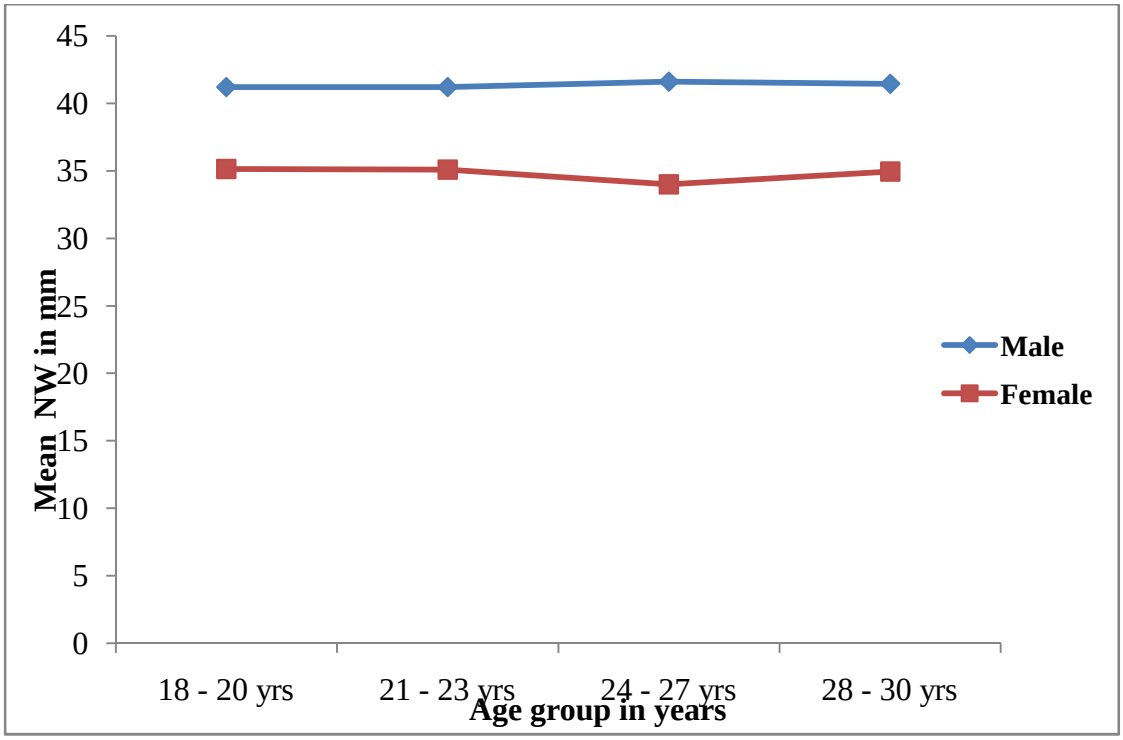

Fig. 3.2: Pattern of the mean nasal width of the participants by age group.

3.3: Inner canthal width

The mean inner canthal width was 34.27 ± 2.68mm with a range of 28.61- 42.46mm Males had a higher mean inner canthal width compared to females (34.73 ± 2.69mm and 33.74 ± 2.58mm respectively) and the difference was statistically significant (t=2.27, p=0.03).

Fig.3.3 shows the mean inner canthal widths for the males and females by age group. Overall, males had higher mean inner canthal widths compared to females for all the age groups.

The relationship between the nasal and inner canthal widths was evaluated revealing a statistically significant weak positive correlation (r=0.41, p=0.00).

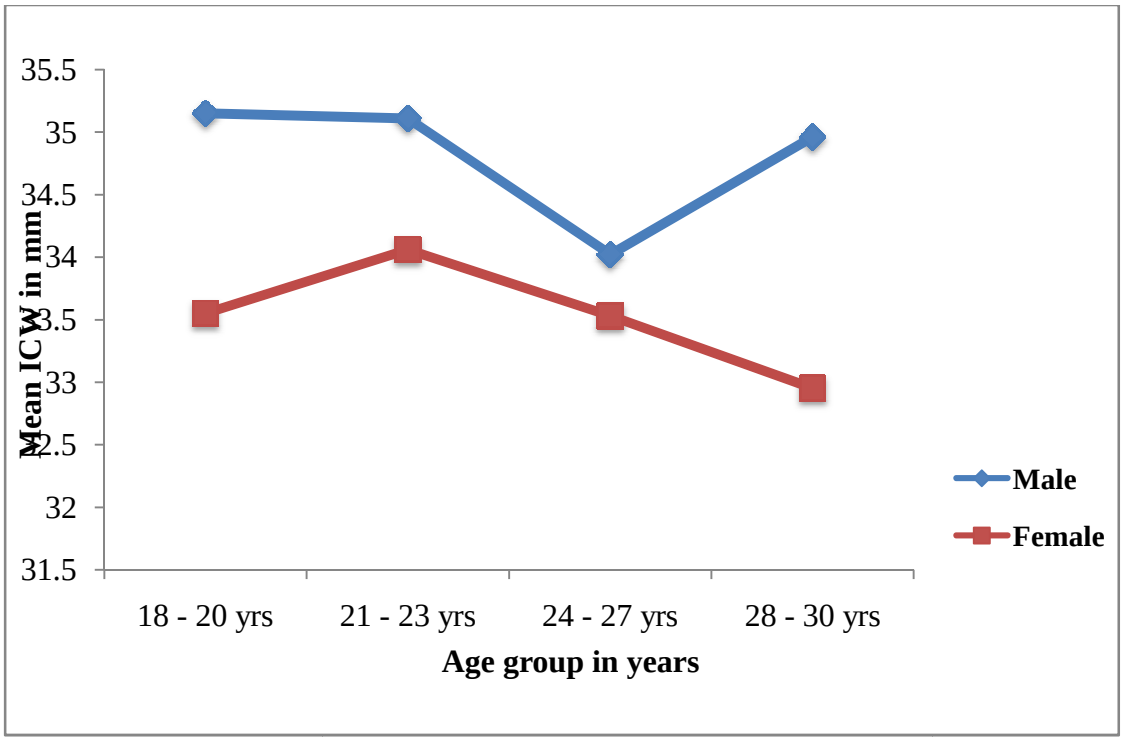

Fig. 3.3: Pattern of the mean inner canthal width of the participants by age group.

3.4: 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). There was a weak negative correlation between age and CMDWAT but this was not statistically significant(r = -0.10, p = 0.22). Table 1.3 shows the mean MDWAT. 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 3.1: 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

Fig. 3.4 shows the mean combined mesio-distal width of the maxillary anterior teeth for the different age groups. Overall, males had higher mean CMDWAT values compared to females for all the age groups studied. The mean values were lower for the age group 28-30 years due to the number of participants in that age group being the least (5 males and 3 females respectively).

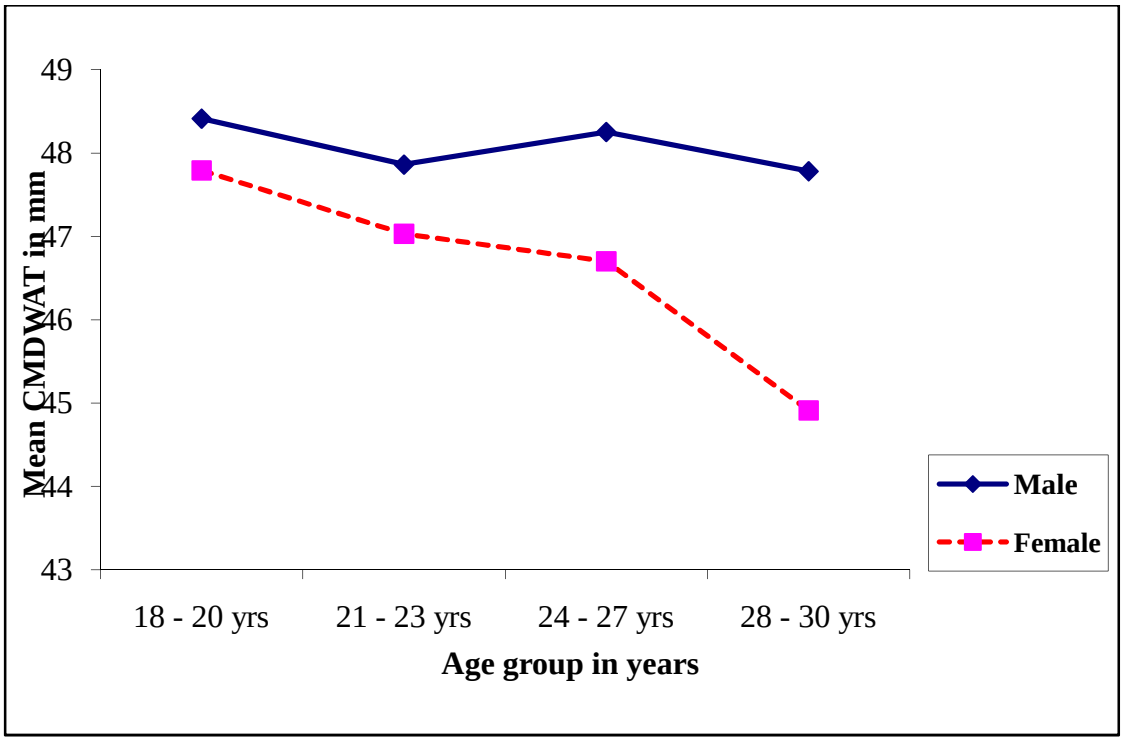

Fig. 3.4: Mean combined mesio-distal width of the anterior teeth by gender and age.

3.5: Nasal width and mesio-distal width of maxillary anterior teeth

The relationship between the nasal and combined mesio-distal widths of the maxillary anterior teeth was evaluated. Table 3.2 shows the Pearson product moment correlation between the nasal and combined mesio-distal widths of the anterior teeth. Overall, a statistically significant weak positive correlation was found 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).

Table 3.2: Correlation between the nasal width and mesio-distal widths of the anterior teeth

Tooth type	r	r^2	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

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_o-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

Table 3.3: 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		P value
			Lower	Upper	(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

Table 3.3 shows the results of the linear regression analysis to show the use of nasal width in predicting the combined mesio-distal width of the maxillary anterior teeth (r^2 =0.07).

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).

3.6: Inner canthal width and mesio-distal width of maxillary anterior teeth

The relationship between the inner canthal and combined mesio-distal widths of the anterior teeth was evaluated. Table 3.4 shows the Pearson product moment correlation between the inner canthal and combined mesio-distal widths of the anterior teeth. Overall, a statistically significant weak positive correlation was found between the inner

canthal and combined mesio-distal widths of the maxillary anterior teeth. In terms of the individual mesio-distal tooth widths, only the canines displayed a statistically significant weak positive correlation with the inner canthal width.

Table 3.4: Correlation between the inner canthal and mesio-distal widths of anterior teeth.

Tooth type	r	r^2	P value (α=0.05)
Right canine	0.26	0.07	0.00*
Right lateral incisor	0.06	0.00	0.45
Right central incisor	0.12	0.01	0.15
Left central incisor	0.13	0.02	0.12
Left lateral incisor	0.09	0.01	0.29
Left canine	0.31	0.10	0.00*
Combined mesio-distal width	0.18	0.03	0.03*

*Statistically significant

Table 3.5: Linear regression analysis to demonstrate the relationship between the inner canthal width and combined mesio-distal width of the anterior teeth.

Variable	B value	Beta	t value	95% CI		P value
				Lower	Upper	
Inner canthal width	0.14	0.15	1.80	-0.01	0.30	0.08
Gender	-0.96	-0.19	-2.24	-1.80	-0.11	0.03*
Age	-0.14	-0.14	-1.70	-0.30	0.02	0.09
Constant	47.27	3.58	40.39	-	-	0.00

*Statistically significant

The association between inner canthal width and combined mesio-distal width of the anterior teeth was evaluated using a multiple linear regression model using the equation;

$y = \beta 0 + \beta x + \varepsilon$

Where,

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

β_o -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 inner canthal width in mm

ε - represents other factors that may influence the dependent variable

Table 3.5 gives the results of the linear regression analysis to show the use of the inner canthal width in predicting the combined mesio-distal width of the maxillary anterior teeth (r^2 =0.03).

The regression analysis yielded a coefficient of determination (r^2) of 0.03 which refers to the amount of variation explained by the independent variable. Therefore, only 3% of the variation in change in the combined mesio-distal width of the anterior teeth can be

explained by the inner canthal width. Gender was a significant predictor of the change in the combined mesiodistal width of anterior teeth ($t=-2.24$, $p=0.03$).

CHAPTER 4

4.0: DISCUSSION

Complete edentulism is a problem affecting every race worldwide[1, 2] that necessitates oral rehabilitation of the edentulous patient through fabrication of a set of complete dentures which may be either conventional or implant supported. Regardless of the type of prosthesis fabricated, the right size of anterior teeth should be selected in order to restore aesthetics and provide a prosthesis that is aesthetically acceptable. Anterior tooth size selection is a great challenge for the clinician when the patient lacks pre-extraction records such as casts, photographs, radiographs and extracted teeth [5, 6].

In the absence of these pre-extraction records, attempts have been made to use various anthropometric measurements as guides to estimate the size of artificial anterior teeth for the edentulous patient but to date, there has been no consensus on a reliable method for anterior tooth selection for the edentulous patient[5, 6, 31]. The nasal and inner canthal widths are some of the facial measurements that have been explored as reliable guides to predict the mesio-distal width of anterior teeth for complete denture patients.

The nasal width for the present study is comparable to that reported in a similar study among Malaysian populations[12, 14] who reported a mean nasal width of 39.36 ± 3.12mm. Studies among other Caucasian populations have reported lower mean nasal widths compared to the current study[17, 23, 26, 29] while a study among a Brazilian population[19] 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[25]. Variability in measuring techniques whereby some authors have taken measurements

from facial photographs analyzed using an image analyzing software as opposed to direct clinical measurements using digital calipers could also explain the differences. The different instruments used in taking the measurements whereby different authors used either a vernier caliper, Willis gauge[23] or Boley gauge[17] could also lead to variation in the mean values obtained since the accuracy of each of these instruments may vary since some did not indicate whether the instruments were calibrated or not.

The current study also reported a higher mean nasal width (Fig 3.2) for males compared to the females (t=7.75, p=.000) which is in agreement with reports from other studies[14, 16, 19, 26], a finding that could be attributed to sexual dimorphism whereby males have generally been found to have larger facial features compared to their female counterparts.

The mean inner canthal width for the population studied was comparable with that reported by similar studies[14, 22, 29] while others reported lower mean inner canthal widths [20, 21, 24, 28] compared to the present study. The differences in the mean values reported could be attributed to racial variation whereby most of the studies were conducted among Caucasian populations with only one study involving an African population of Sudanese origin[28]. Different instruments used while taking the measurement clinically such as the use of the Boley gauge[20, 21, 24] and digital calipers[28] could also have led to the differences in the mean values obtained. The age of the individuals studied could have had an influence on the mean values reported whereby for some authors this ranged between 17-57 years[24] while for the current study the range was between 18-30 years. Males had higher mean inner canthal widths compared to females (Fig 3.3, t=2.27, p=0.03), a difference that is consistent with findings of other authors [14, 20] who reported higher mean values in males compared to females. However, a study among a Brazilian population[14]

reported no statistically significant difference in the mean ICW between the males and females.

Studies among Caucasian populations have reported mean combined mesio-distal widths of the maxillary anterior tooth values ranging between 42.16mm and 60.33mm[12, 13, 14, 16, 17, 20, 22, 24, 31, 32]. The current study reported a mean combined mesio-distal width of the maxillary anterior teeth (MDWAT) that was within the range reported by other authors. The differences in the mean values could probably be due to racial differences between Caucasian and African populations whereby studies have reported African populations as having wider teeth compared to their Caucasian counterparts. The different techniques employed while carrying out mesio-distal tooth width measurements of the maxillary anterior teeth could have yielded different results. 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[41]. The researcher may also not have a chance of recalling the subjects to repeat the measurements incase of errors 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 values obtained since the abrasion resistance of type IV gypsum used for the current study is superior to that of type III[47]. Therefore measurements taken from casts generated from the former material are likely to be more accurate compared to those measured from the latter. 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 whereby some measured on a curve between the distal aspects of the two maxillary canines at the contact points. Some undertook the measurements on a curve but between the cusp tips of the two canine[28] while others 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.

Males had a higher mean combined MDWAT compared to the females (t=2.30, p=0.02), a finding that is consistent with reports from other studies conducted among different populations [11, 14, 20, 25, 26, 44]. 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 [28, 41, 45, 46].

The relationship between the nasal width, the inner canthal width and the combined mesio-distal width of the maxillary anterior teeth was also investigated. The present study reported statistically significant weak positive correlations between the nasal and widths 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). Therefore, the null hypothesis that there is no association between the nasal width and combined mesio-distal widths of the maxillary anterior teeth is rejected. These findings are comparable to reports by other authors[17, 38]. However, this only represents a small proportion of the population with more than 90% of the population studied not accounted for.

Statistically significant weak positive correlations were also reported between the inner canthal width and combined mesio-distal width of the anterior teeth in 3% of the population and inner canthal width and the width of the canines in 10% of the population studied (r^2=0.03 and r^2= 0.10 respectively). Therefore, the null hypothesis that there is no association between inner canthal and combined mesio-distal widths of the maxillary anterior teeth is rejected. This finding is in agreement with findings by others[27, 28] who have reported weak positive correlations between the inner canthal width and the combined mesio-distal width of the six maxillary anterior teeth. However, the authors did not report on the percentage of the population in which these facial measurements were correlated hence the results were inconclusive.

CONCLUSIONS

Based on the findings of the study, it can be concluded that:

1. The mean nasal width was 39.54 ± 3.61mm with statistically significant differences in mean values between the males and females (t=7.75, p=.000).
2. The mean inner canthal width was 34.27 ± 2.68mm with statistically significant differences in mean values for males and females (t=2.27, p=0.03).
3. The mean combined mesio-distal width of the maxillary anterior teeth was 47.68 ± 2.55mm with statistically significant differences in the mean values between the males and females (t=2.30, p=0.02).
4. The study found a weak positive correlation between the nasal and inner canthal widths and the combined mesio-distal widths of the anterior teeth.

5. The nasal and inner canthal widths were reliable in predicting the mesio-distal width of the six maxillary anterior teeth in only 7% and 3% of the population respectively. Therefore, the two facial measurements cannot be used as reliable guides in predicting the mesio-distal width of the six maxillary anterior teeth for the Kenyan population of African descent.

RECOMMENDATIONS

1. There is need to put emphasis on the essence of keeping pre-extraction records in order to ease the process of anterior tooth selection for the edentulous patient.
2. Further research needs to be carried out in a larger sample of the population so as to allow for more reliable extrapolation of the results to the general population.

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APPENDICES

APPENDIX I: CONSENT FORM

I am a postgraduate student pursuing a Master's Degree in Prosthodontics at the University Of Nairobi School Of Dental Sciences. I wish to conduct a study on "**Relationship between the nasal, inner-canthal and mesio-distal widths of the maxillary anterior teeth in a Kenyan Population of African descent**".

Perceived benefits

The information obtained from the study will be useful to clinicians offering oral and facial rehabilitative services to patients and ease the process of artificial anterior tooth selection. The study will also serve as a partial fulfillment for a Masters Degree in Prosthodontics.

I…….consent to take part in this study as explained to me by the principal investigator. I understand that all the information given by me and the clinical finding obtained shall be held and treated with confidentiality and shall be used solely for the purpose of the research.

Signature of the participant…….Date……..

Signature of investigator……Date……

APPENDIX II: DATA CAPTURING SHEET

Code……

Patient's age (years)……..

Gender male female

Nasal width(mm)……1st value……...2nd value……Average……

Inner-canthal width (mm)…1st value……2nd value……Average…….

Mesio-distal widths of the maxillary anterior teeth (mm)……

Tooth number	1st value (mm)	2nd value (mm)	Average value (mm)
13			
12			
11			
21			
22			
23			

APPENDIX III: LINEAR REGRESSION ANALYSIS MODEL

Linear regression analysis was used to evaluate the association between the nasal and combined mesio-distal widths of the anterior teeth; and the inner canthal width and combined mesio-distal widths of the anterior teeth after controlling for age and gender. The model used was;

$y = \beta 0 + \beta_1 x + \beta_2 x + \beta_3 x + \varepsilon$

Where,

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

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

β_1- is the slope of the line (amount by which y changes for each unit change in x)

β_2 - is the gender

β_3- is the age

x- is the nasal width or inner canthal width in mm

ε - represents other factors that may influence the dependent variable

APPENDIX IV: ETHICAL APPROVAL

KENYATTA NATIONAL HOSPITAL
Hospital Rd. along, Ngong Rd.
P.O. Box 20723, Nairobi.
Tel: 726300-9
Fax: 725272
Telegrams: MEDSUP", Nairobi.
Email: KNHplan@Ken.Healthnet.org

Ref: KNH-ERC/ A/548

5th August 2010

Dr. Rael Moraa Ariemba
Dept.of Conservative and Prosthetic Dentistry
School of Dental Sciences
University of Nairobi

Dear Dr. Ariemba

RESEARCH PROPOSAL: "RELIABILITY OF NASAL AND INNER CANTHAL WIDTH(S) IN ESTIMATING THE MESIO-DISTAL WIDTHS OF THE MAXILLARY ANTERIOR TEETH IN A KENYAN POPULATION OF AFRICAN DESCENT" (P174/6/2010)

This is to inform you that the KNH/UON-Ethics & Research Committee has reviewed and **approved** your above revised research proposal for the period 5th August 2010 to 4th August 2011.

You will be required to request for a renewal of the approval if you intend to continue with the study beyond the deadline given. Clearance for export of biological specimens must also be obtained from KNH/UON-Ethics & Research Committee for each batch.

On behalf of the Committee, I wish you a fruitful research and look forward to receiving a summary of the research findings upon completion of the study.

This information will form part of the data base that will be consulted in future when processing related research study so as to minimize chances of study duplication.

Yours sincerely

PROF A N GUANTAI
SECRETARY, KNH/UON-ERC

c.c. Prof. K. M. Bhatt, Chairperson, KNH/UON-ERC
The Deputy Director CS, KNH
The Dean, School of Dental Sciences, UON
The HOD, Records, KNH
Supervisors: Dr. S. K. Amisi, Dept.of Conservative and Prosthetic Dentistry, UON
Dr. E. W. Kibugi,Dept. of Conservative and Prosthetic Dentistry, UON
Dr. S. Maina, Dept.of Conservative and Prosthetic Dentistry, UON
Dr. L. W. Gathece,Dept.of Period., Community and Preventive Dentistry, UON