

Assessment of Upper Anterior Tooth Dimensions and Relationship in a Young-Adult-Black-Urban-Zimbabwean Population

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Abstract

Introduction: Knowledge of tooth dimensions and relationships are important in clinical decision making and patient management.

Aim: The aim of the present study was to investigate aspects of the dimensions and relationships of the upper anterior teeth in a sample of Zimbabweans and compare the findings with existing data for Caucasians.

Materials and Methods: Seventy male and 70 female Zimbabweans were recruited to the study. Full arch stone casts and photographs were obtained for each participant. The width and length of the 840 upper anterior teeth included in the casts were measured, together with the combined upper anterior tooth width for each cast. The error of the method was investigated by means of repeat measurements. Golden proportion relationships and the apparent contact dimension (ACD) percentage ratio were investigated.

Results: Most measurements had a normal distribution. ANOVA failed to reveal any significant gender differences, with the exception of upper lateral incisor width in males. The only left-right difference was in the width of male upper lateral incisors. Golden proportion ratios were not found. The ACD ratio was close too ideal: 49%: 39.5%: 29.6%. No significant differences were found between the findings and data for Caucasians.

Conclusions: Dimensional features of upper anterior teeth in black Zimbabweans may be found to include: No left/right differences, except for the width of male lateral incisors. No lateral incisor gender differences. An absence of golden proportion relationships. ACD percentage ratio of: 49.0%: 39.5%: 29.6%. Tooth dimensions and relationships in black Zimbabweans are similar to those of Caucasians.

Clinical significance: Knowledge of tooth morphology, dimension and relationship is fundamental to, in particular, restorative and aesthetic dental procedures. Knowledge of the relationship between width and length of different tooth types and variation in the tooth width-length relationship is important in clinical decision making processes and subsequent patient management.

Keywords: *Tooth Dimensions; Upper Anterior Teeth; Apparent Contact Dimensions; Mesiodistal; Apico-coronal*

Introduction

There continues to be growing interest in dental aesthetics amongst dentists and patients and in the media [1]. Aesthetics–dental attractiveness is now one of the primary considerations of many patients seeking dental care [2,3].

Pleasing dental appearance is associated with enhanced quality of life and general wellbeing [1]; dental appearance being related to personal confidence and how one is judged by society [4-6]. The smile is the most important and evocative facial expression, with the upper anterior teeth being a key component [5]. Treatment that restores form and function, but without sufficient attention to aesthetics may not be considered to have been successfully completed, and may result in patient dissatisfaction [7,8].

Advances in dental biomaterials science, together with improvements in clinical techniques, have given dental teams the opportunity to meet ever-increasing patient expectations of aesthetically pleasing clinical outcomes. However, without detailed knowledge and understanding of tooth parameters, morphology and relationships, such advances and improvements may be applied too little, if any advantage.

The relationship of the upper anterior teeth, in the absence of imbrication, is in large part, determined by tooth widths, which, as a consequence, play an important role in both dental and facial aesthetics [9,10].

Tooth size varies between different ethnic groups [11-14]. Gender variation in tooth size has been noted in most races, with teeth in males being typically larger than in females [15-17]. This body of evidence, helpful as it is, lacks data on tooth dimensions in black people, in particular black people living in Africa.

The principles of symmetry, proportion and dimension are important concepts in restorative dentistry. Tooth dimensions are important, objective data in smile design [18]. However, ideal tooth dimension may be difficult to determine, given that, there are individual variations [19-21]. To account for this, various guides in the form of 'magic numbers' and proportions have been proposed. These include the Golden Proportion (GP) [22], Preston's Proportion (PP) [23], the Golden Percentage (G%) [24], the Recurring (a) esthetic Dental Proportion (RED) [25] and the Gauge Proportion (GaugeP) [26].

GP, the oldest and best known of these proportions, is premised on a 62% reduction, from front to back, of the perceived widths of the upper anterior teeth [22]. It is suggested that adjacent teeth which display this ideal ratio have a more aesthetically pleasing appearance [27]. A number of papers, however, report that GP may not be a feature of the natural dentition [16,18,28].

Aim

With the growing interest within multiracial societies in dental and facial aesthetics, it is suggested that more information is required on variations in tooth morphology, dimensions and relationships in different ethnic groups to help inform treatment planning in different restorative and dental aesthetic procedures.

The aim of the present study was to obtain data on upper anterior tooth dimensions and relationships in a group of young, adult, black, urban Zimbabweans, and to compare the data obtained with available data on Caucasian teeth [15].

Materials and Methods

This study was approved and conducted in strict accordance with requirements of the Biomedical Science, Dentistry, Medicine and Natural and Mathematical Sciences Research Ethics Subcommittee (BDM RESC) King's College London (BDM/13/14-40) and the Medical Research Council of Zimbabwe (MRCZ/B/623). This research has been conducted in accordance with the world Medical Association Declaration of Helsinki (2013).

Subject recruitment

A total of 140 volunteers, comprising 70 males and 70 females, were recruited to the study. Recruitment was mainly by means of posters placed in various public health institutions and private dental clinics in Harare, and from patients attending the principal author's practice for dental care.

The subject selection criteria were:

1. Between 18 and 30 years of age
2. One or both parents of black African lineage
3. Intact upper and lower anterior dental arches
4. No anterior restorations or crowns

5. No evidence of pathological tooth wear or trauma
6. No evidence of established periodontitis
7. No crowding and imbrications
8. Acceptance of the requirements to participate in the study
9. The subjects were free at any time to withdraw from the study

Impressions and study casts

Having obtained consent, as required by the BDM RESC of King's College London and the Medical Research Council of Zimbabwe, alginate impressions (Blueprint 20+, Dentsply DeTrey GmbH, Konstanz, Germany) of the maxillary and mandibular arches were recorded in disposable, single-use stock impression trays as follows:

The trays were lightly coated with tray adhesive liquid (Pegasus Dental Supplies, Cheshire, UK) at least five minutes prior to their use.

The alginate was mixed by hand using a spatula, according to the directions of the manufacturer. The stock tray was loaded with impression material. Some material was smeared over the labial and incisal surfaces of the anterior teeth, with the intention of obtaining good surface and interdental detail. The loaded tray was then seated in the mouth, supported and removed once the impression material had set.

The impression was washed under running tap water and immersed in a disinfectant [CIDEX OPA (ortho-phthaldehyde) Johnson and Johnson, Berkshire, UK] solution for one minute.

Following disinfection, the impression was once again washed under running water, inspected for defects and poured, within 10 minutes of its removal from the mouth, using Type IV stone (Exudura Die stone, Hebor Espanola, SA, Guadalajara, Spain). Any impression found to include a defect which may have adversely influenced the recording of accurate measurements of the anterior teeth was rejected and repeated.

Once the die stone had set (> 60 minutes after pouring), the casts were carefully removed from the impressions, trimmed and identified with the participant's unique study number in black, indelible ink. The cast were then allowed to bench dry for 24 hours. Prior to examination, each set of study casts were stored in a card board box wrapped in tissue, with great care being taken to ensure that none of the teeth suffered any chipping or other damage. In the event of any cast being found to be deficient or defective on removal from an impression or following storage, the participant was recalled and the impression and pouring of the cast repeated.

Clinical photographs

Following successful recording of the upper and lower alginate impressions, a standardised frontal view of each patient's anterior dentition was recorded. For the purpose of these clinical photographs, the patient's lips and cheeks were retracted using locally sourced, standard disposable plastic cheek retractors. The patient was guided in the arc of closure to a position in which the incisor teeth were separated to the extent that the incisal edges of both maxillary and mandibular teeth could be included in the image. The photographs were recorded digitally using a Nikon D3100 digital camera at a manual setting; shutter speed 1/125 and aperture F5.6, to ensure that the field of view for each photograph was identical. Any image found to be inadequate was immediately repeated. The images were uploaded and imported as Jpeg files to an MSI CR620 personal computer and stored. Measurements were made directly on the stone casts of the maxillary arches.

Width and length of teeth

Prior to any measurements being taken each cast was carefully examined under magnification (X2.5) to identify the various dental landmarks and features.

A digital sliding scale calliper (Toolquip Precision Measuring, Johannesburg, SA) was used to complete the measurements (mm) of the width and apico-coronal length of the clinical crown of each tooth included in the study.

The tips of the callipers were held at right angles to the long axis of the tooth for the widest mesiodistal measurements and parallel to the long axis of the tooth for measurements of the apico-coronal length, as described in previous studies [10,15]. Each measurement (mm), considered to be to the nearest 0.01 mm, was repeated at least three times, or as often as was required to yield a consistent value.

Canine to canine measurement

The combined width (mm) of the maxillary anterior teeth- distal of canine too distal of the contralateral canine was measured using a flexible apparel measuring tape (Perfect Measuring Tape Company, Toledo, Ohio, USA). For these measurements, the tape was adapted across the labial surfaces of the teeth, at the level of the contact areas, and read to the nearest millimeter. As with measurements recorded using the sliding scale calipers, the measurements with the flexible measuring tape were repeated at least three times, or as often as was required to give a consistent value.

To avoid errors related to fatigue no more than 10 casts were measured in a 24-hour period.

Estimation of golden proportion

The apparent width (mm) of each upper anterior tooth, as seen in a frontal view [29] was measured, using dividers and a millimeter rule, from a Levin's grid drawn on blank card.



Figure 1: Levin grid on white card of upper cast.

The apparent width proportion was then calculated by dividing the apparent width of each tooth by the apparent width of the ipsilateral lateral incisor tooth.

Apparent contact dimension (ACD)

Since the apparent contact dimension is affected by tooth shape, size and orientation [29] upper models with teeth of atypical size, shape and orientation were excluded. In addition, measurements of ACD may only be achieved on study casts if there is clear reproduction of the interdental area. As a consequence, any models with any blurring of the interdental anatomy were excluded.

In total 39 models obtained from male participants were selected and then matched with 39 models from female participants. The cast were hand positioned, with the maxillary occlusal plane parallel to the horizontal, in such a way as to allow each interdental area of interest to be observed at right angles [29]. The apical and incisal extent of the contact area was then marked in pencil (Figure 2). The distance between the two pencil markings was then measured (mm) using a digital Vernier caliper. Each measurement was repeated until a consistent reading was obtained.

The ACD percentage- the ratio of ACD to the length of the ipsilateral central incisor, was calculated for each contact area included in the investigation.



Figure 2: Upper cast with apparent contact dimensions marked in pencil.

Assessment of surface texture

A subjective assessment of tooth texture was made from the digital photographs of the anterior teeth of all participants, using Windows photo viewer. The surface of each tooth was assessed as either smooth/shiny or coarse/matt.

Statistical analysis

Mean tooth dimensions were calculated for each tooth type in the male and female participants. The range, mean, standard deviation and coefficient of variation were recorded. The data was input into a SPSSV.21 statistical software package for analysis.

ANOVA was performed to determine differences, if any, between mean values for tooth width, length, intra- and inter- tooth ratios in the male and female participants.

Paired student t-tests were used to compare left and right values obtained for male and female participants. Pearson's correlation was used to assess the relationship between ACD and tooth length. Unpaired student t tests were used to compare mean values obtained in the present study with mean values reported in a similar study in a Caucasian population [15].

Error of the Method

The error of the method was determined using the method described by Olsson and co-workers [30]. Ten upper casts were selected at random. The mean measurements of the length and mesiodistal width of the upper anterior tooth types; central incisors, lateral incisors and canines were recorded twice, using the technique adopted for the study, with an interval of one-week. The repeat measurements were made with no reference to the initial findings.

The variation in the measurement of each parameter assessed was calculated as the standard deviation of the difference in the two measurements, to give an estimate of the error of the method (mesiodistal width, 0.06 mm; a pico-coronal length, 0.03 mm).

Results

One hundred and forty subjects entered the study: 70 males and 70 females. The mean age of female participants was 22.2 years, s.d 4.1 years, whilst that of the males was 20.6 years, s.d 3.3 years. The difference between the mean age of the male and female participants was not statistically significant ($p > 0.05$).

Tables 1 and 2 present mean values of the direct measurements (mm) according to gender. There was a statistically significant gender difference in the width and length measurements for all tooth types, except for the width and length of the upper lateral incisor. (width $p = 0.322$, length $p = 0.106$).

	Upper anterior teeth											
	13		12		11		21		22		23	
Gender	width	length	width	length	width	length	width	length	width	length	Width	length
Male	8.2(0.5)	9.5(1.2)	7.2(0.7)	8.4(1.1)	9.1(0.7)	9.8(1.2)	9.1(0.6)	9.7(1.2) *	7.2(0.7)	8.3(1.1)	8.2(0.4)	9.5(1.3)
Range	7.2-9.2	6.6-12.2	5.8-8.9	6.2-10.7	7.2-10.8	6.2-12.4	7.2-10.2	6.3-12.4	5.8-8.7	6.2-10.7	6.1-9.1	6.6-12.6
95% CI	8.1-8.4	9.3-9.8	7.0-7.4	8.1-8.6	9.0-9.3	9.5-10.0	9.0-9.3	9.4-10.0	7.1-7.5	8.1-8.6	8.1-8.3	9.3-9.8
Female	7.7(0.6)	9.1(1.0)	7.2(0.6)	8.2(0.9)	8.8(0.6)	9.5(0.9)	8.8(0.6)	9.5(0.9)	7.2(0.6)	8.2(0.9)	7.7(0.5)	9.1(0.9)
Range	6.1-9.1	7.2-12.0	6.0-8.7	6.2-10.3	7.8-10.2	7.1-11.6	7.8-10.2	7.1-11.7	5.8-8.7	6.2-10.4	6.1-9.1	7.2-12.0
95% CI	7.6-7.8	8.9-9.3	7.0-7.4	7.9-8.4	8.6-9.0	9.3-9.6	8.6-9.0	9.3-9.7	7.0-7.3	8.0-8.3	7.6-7.8	9.0-9.3

Table 1: The mean (mm) standard deviation (SD) range(R) and 95% confidence interval (95%CI) of the widths and lengths of upper anterior tooth types according to side and gender.

	Upper anterior tooth groups					
	Central incisor		Lateral incisor		Canine	
Gender	Width	Length	Width	length	Width	Length
Male	9.1 (0.6)	9.7 (1.2)	7.3 (0.6)	8.4 (1.1)	7.7 (0.5)	9.5 (1.2)
Range	7.2-10.2	6.2-12.4	5.8-8.9	6.2-10.7	7.2-9.2	9.3-9.8
95% CI	9.0-9.3	9.5-10.0	7.0-7.4	8.1-8.6	8.1-8.3	9.3-9.8
Female	8.8 (0.6)	9.5 (0.9)	7.2 (0.6)	8.2 (0.9)	7.7 (0.5)	9.1 (0.9)
Range	7.8-10.2	7.1-11.6	5.8-8.7	6.2-10.4	6.1-9.1	7.2-12.0
95% CI	8.6-9.0	9.3-9.6	7.0-7.3	7.9-8.4	7.6-7.8	8.9-9.3

Table 2: The mean (mm) s.d, R and 95% CI of the widths and lengths of upper anterior tooth types according to gender.

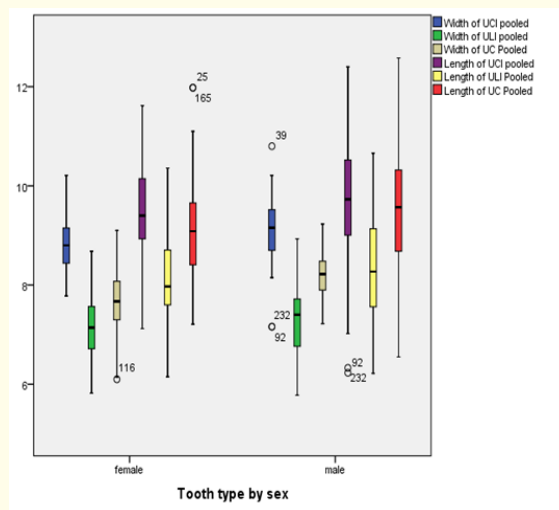


Figure 3: Distribution of widths and lengths of upper anterior tooth groups.

Comparing antimeres, there was no significant difference in length for all tooth types, regardless of gender. However, there was a significant difference in the mesiodistal width of the maxillary lateral incisors of the male participants ($p = 0.011$). The distribution of width and length for each tooth type is shown in Figure 3.

The width/length ratio data obtained are set out in table 3, whilst inter-tooth ratios are summarized in table 4. There were no significant gender differences in tooth ratios ($p > 0.05$).

Upper anterior tooth groups			
Gender	UCI	ULI	UC
Male	0.95(0.09)	0.88(0.09)	0.87(0.11)
Range	0.77-1.37	0.63-1.21	0.65-1.23
95% CI	0.93-0.97	0.86-0.89	0.85-0.89
Female	0.94(0.14)	0.89(0.18)	0.85(0.13)
Range	0.74-1.21	0.69-1.27	0.68-1.04
95% CI	0.91-0.96	0.86-0.92	0.83-0.88

Table 3: Mean width/length ratios (s.d), R and 95% CI of tooth types according to gender (Pooled).

- UCI upper central incisor
- ULI upper lateral incisor
- UC Upper canine

Tooth type						
Gender	UCI/ULI		UCI/UC		ULI/UC	
	width	length	width	length	width	length
Male	1.27(0.06)	1.17(0.08)	1.12(0.05)	1.03(0.09)	0.88(0.06)	0.87(0.07)
Range	1.07-1.62	0.93-1.56	0.99-1.29	0.67-1.42	0.69-1.04	0.66-1.21
95% CI	1.26-1.29	1.15-1.19	1.11-1.13	1.01-1.05	0.87-0.89	0.87-0.89
Female	1.23(0.12)	1.17(0.13)	1.15(0.09)	1.05(0.13)	0.94(0.11)	0.90(0.10)
Range	1.01-1.54	1.01-1.65	0.98-1.34	0.87-1.41	0.76-1.15	0.69-1.03
95% CI	1.20-1.26	1.14-1.20	1.13-1.17	1.03-1.07	0.92-0.96	0.88-0.92

Table 4: Inter tooth width/width and length/length ratios (s.d), R, and 95% CI according to gender (Pooled).

Canine- canine arch perimeter

Comparison of the canine-canine arch perimeter findings obtained using the flexible tape measure and the sum of the individual mesiodistal width of all the upper anterior teeth obtained from the digital calliper measurements revealed consistently higher mean values when using the flexible tape measure < 5 mm.

Golden proportion estimation

The mean apparent width ratio is obtained by finding the mean of the apparent width of each tooth type as related to the apparent widths of the lateral incisor of the same side are shown in table 5. These mean values indicate that golden proportion (GP) was absent in the present sample.

	Ideal	Mean	95% Confidence Interval		Coefficient Of Variation
			LOWER	UPPER	
UCI	1.618	1.496	1.466	1.526	0.010
ULI	1.000	1.000	1.000	1.000	0.000
UC	0.618	0.677	0.602	0.752	0.054

Table 5: Mean apparent width ratios relative to the upper lateral incisor.

Cross tabulation indicated- in contrast to 9% of the female participants, that no male participant central incisor had a GP ratio of 1.618. A Chi-square test showed this gender difference to be statistically significant (p = 0.00).

Among male participants, 11% had an ideal canine to lateral incisor ratio (0.618). The corresponding value for the female participants was 10%, with an overall proportion of 10.7%. This gender difference was not significant: p = 0.699.

Apparent contact point percentage ratio

The average apparent contact point percentage ratio for the selected sample is shown in table 6. Results of a paired t-test did not show any difference between different sides and as such were combined.

Table 6 reveals a close correlation between the two variables. The Pearson’s correlation coefficient showed an increase towards the midline, as revealed in table 7.

	UCI/ UCI	UCI/ ULI	UCI/ UC
Mean	49.3	39.5	29.6
N	78	156	156
SD	1.8	1.8	1.5

Table 6: Apparent contact point percentage ratio.

Region of ACD	Pearson correlation Coefficient
ACD Midline Versus length of UCI	0.912
ACD UCI/ULI versus length of ULI	0.731
ACD UC/ULI versus length UC	0.619

Table 7: Pearson’s correlation table of ACD versus length of tooth.

Tooth surface texture

Results of tooth surface texture are shown in Figure 4. Most tooth surfaces in the sample assessed were smooth (male 84%; female 89%; overall, 87%). This gender difference was not found to be significant (p > 0.05).

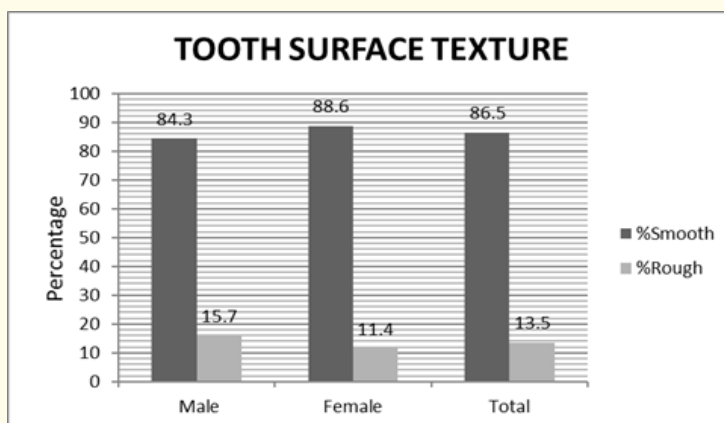


Figure 4: Tooth surface texture bar chart.

Comparisons with existing data

The mean values obtained in this study were compared statistically with data previously reported by Sterret and co-workers, for a group of 24 males and 47 females Caucasian group. Between- group differences were evaluated for statistical significance by the ‘t’ test for independent variables at $p < 0.05$. The results are shown in tables 8 and 9. The t-test showed no significant differences between the mean length, width and width/length ratios between the two studies. This implies that there is no difference in the dimensions investigated in the two populations.

	Gender	Dimension	Current study				Sterret and co-workers				P-value
			N	Mean	SD	range	N	Mean	SD	range	
UCI	Male	width	70	9.1	0.57	7.2-10.8	24	8.6	0.47	7.6-9.4	0.3783
		length	70	9.8	1.21	6.2-12.4	24	9.7	1.2	6.2-12.4	0.4129
	Female	width	70	8.8	0.56	7.8-10.2	47	8.1	0.66	6.8-9.5	0.2709
		length	70	9.5	0.87	7.1-11.7	47	9.5	0.9	7.1-11.6	0.4761
ULI	Male	width	70	7.2	0.64	5.8-8.9	24	6.6	0.45	5.8-7.7	0.3121
		length	70	8.4	1.11	6.2-10.7	24	8.7	0.78	6.6-10.2	0.4247
	Female	width	70	7.2	0.61	5.8-8.7	47	6.1	0.59	4.8-7.2	0.1131
		length	70	8.2	0.87	6.2-10.4	47	7.8	0.99	5.8-9.8	0.3745
UC	Male	width	70	8.2	0.44	6.1-9.2	24	7.6	0.3	7.0-8.2	0.3483
		length	70	9.5	1.23	6.6-12.6	24	10.1	1.0	7.7-11.7	0.3859
	Female	width	70	7.7	0.54	6.1-9.1	47	7.2	0.4	6.4-8.2	0.3228
		length	70	9.1	0.93	7.2-12.0	47	8.9	1.0	7.1-10.9	0.4364

Table 8: Computation of p-values for width and lengths between current study and Sterret et al. 1999 [15].

		Current study				Sterret and co-workers				p-value
		N	Mean	SD	Range	N	Mean	SD	Range	
UCI	Male	70	0.95	0.11	0.77-1.37	24	0.85	0.09	0.65-1.02	0.2810
	Female	70	0.94	0.09	0.74-1.21	47	0.86	0.07	0.72-1.04	0.2611

ULI	Male	70	0.88	0.11	0.63-1.21	24	0.76	0.09	0.63-1.04	0.2206
	Female	70	0.89	0.11	0.69-1.27	47	0.79	0.09	0.64-1.00	0.1660
UC	Male	70	0.87	0.11	0.65-1.23	24	0.77	0.08	0.66-0.97	0.2611
	Female	70	0.85	0.11	0.68-1.04	47	0.81	0.07	0.68-0.97	0.3897

Table 9: Computation of p-values for width/length ratios between current study and Sterret et al 1999 [15].

Discussion

The Zimbabwean population is formed of an admixture of indigenous people and economic migrants from countries of the former Federation of Rhodesia, Nyasaland and Mozambique. It is a relatively young population.

The present study investigated the dimensions and certain relationships of the maxillary anterior teeth in a sample of young adult, black, urban Zimbabweans. Such dimensions and relationships, while important in the provision of, in particular, aesthetic dentistry and orthodontics in Zimbabweans, provide an opportunity to investigate possible differences in anterior tooth dimensions and relationships between Zimbabweans and other population groups. Knowledge of any such differences is important in the provision of treatment in multicultural societies and in developing a better understanding of tooth dimensions and relationships in different ethnic groups.

Limitations

Despite careful planning and the adoption of techniques and procedures used in previous studies of a similar nature, the present study suffered certain limitations. These included the relatively limited size of the sample studied, recruiting only dental attenders to participate, and the lack of precision of the methods used to measure the teeth, albeit that the error of the method was found to be small. Overall, the limitations of the study were not considered to have resulted in the reporting of misleading data.

Direct tooth measurements

The rank order of the teeth (largest to smallest) according to both mesio-distal width and apico-coronal length was: Upper central incisor > upper canine > upper lateral incisor. This is consistent with previous studies [9,15-17,31,32].

Difference in tooth width between antimeric teeth was prevalent in a sample of a black south African urban population [33]. The reason for this finding was attributed to the high disease and malnutrition burden in this population [33].

In the present study, no statistically significant left/right differences between contralateral teeth in respect of width and length, except for the width of the upper lateral incisor, which was significantly different in the male participants only ($p = 0.011$). These findings support the findings of Gongalves and co-workers [34]. The clinical significance of this finding is that clinicians should be mindful of the asymmetry in lateral incisors in this population.

Mavroskoufis and Ritchie [35] found 86-90% left/right differences in width in measuring 70 left and 70 right central incisors. In contrast, an earlier study of 658 incisors failed to show such difference [36].

Sexual dimorphism was prevalent in this study, notably tooth width and length for upper central and upper canine tooth types. In contrast, the lateral incisors did not exhibit statistically significant gender differences in either width ($p = 0.322$) or length ($p = 0.106$). In a similar study, Condon and co-workers [32] found statistically significant gender difference in only the lengths of the lateral incisor in a young Irish population. In contrast, a recent study by Calçada and co-workers [16] using digital photography in a Portuguese sample, found gender difference in only the width of the upper left lateral incisor. Gender differences in anterior tooth dimension have been noted in most races, with men tending to have teeth of larger dimensions than women [9,15-17].

Tooth ratios

No gender differences in tooth width/length ratios were identified in the present study. This supports previous findings by Condon and colleagues [32]. Some studies have, however, found significant gender differences in width/length ratios for maxillary canines [9,15,31].

It is suggested, therefore, that width/length ratios may at best be a helpful guide in the restoration or replacement of central and lateral incisors. Width/ratios in the present study ranged from 63% to 127%. The average of 90% is higher than previously reported -81% [15]. This indicates that width/ratios may not be consistently applied in the management of patients of different ethnicity.

Arch perimeter estimation

Arch perimeter estimates using a flexible ruler (measuring tape) were consistently greater (> 5 mm) than the sum of the widths of individual teeth in the arch, excluding any arches including imbrications and diastema. The observed difference may be related, at least in part, to the convexity of the teeth included in an arch and tooth alignment, whereby the nature of the proximal contact between teeth resulted in an increase in the arch perimeter estimate, relative to the sum of the mesio-distal widths as measured at right angles to the labial surfaces of the teeth. This finding suggest that if arch perimeter estimates are to be used clinically, the method used should be stipulated, or at least two estimates provided –one using a flexible ruler and the other based on the sum of the mesio-distal dimensions of the relevant teeth. In this way, a measure of the range of possible arch perimeter estimates may be recorded and communicated as appropriate.

The mean arch perimeter estimates recorded in the present study using a flexible rule were similar to those reported in previous studies using similar techniques [34,37,38].

Golden proportion estimates

Golden Proportion (GP) ratios were not found to be a feature of the anterior dentitions of the sample investigated in the present study. No male participant was found to have either the GP central incisor to lateral incisor length or width ratio of 1.618, as proposed by Levin and Lombardi [22,39]. In contrast, 8.6% of the female participants were found to have the GP ratio for the width or length these teeth. A Chi-squared test indicated that this gender difference was statistically significant ($P = 0.0000$). Despite this difference, the absence of GP ratios was the norm and, as such, could not be recommended as a guide in developing an aesthetically pleasing anterior dentition, as previously proposed [22,39]. Indeed, given that GP ratios have been found to be present occasionally only, if at all in the natural dentition by other workers [9,16,28,31,32,40] whichever way the teeth are viewed; it is suggested that this ratio should be considered to be irrelevant to considerations of the dentition. Interestingly, in a study of computer-manipulated images, dentist ranked dentitions including GP ratios to be the least pleasing in appearance [41].

This finding, subsequently supported by Ward [42], reinforced the findings of a similar investigation involving lay people [43].

Apparent contact dimension

ACD, defined as the area where teeth appear to be in contact, when viewed at 90 degrees from the front [29], has been promoted as a proportion to quantify smile aesthetics. Morley and Eubank [44], theorized that the ideal ACD proportions for upper maxillary teeth should be 50%:40%:30%, i.e., the ACD between central incisors should be 50%, central and lateral incisors 40% and lateral incisors and canines 30%. Vishnu and co-workers [29] subsequently confirmed the existence of such a proportion. The findings from the present study demonstrated that the individuals investigated had near ideal ACDs: 49.3%:39.5%:29.6%. It is to remembered, however, that the individuals who participated in the study were required to satisfy various criteria which may have influenced the ACD findings. Accepting this limitation, it is suggested that the ideal ACD of 50%:40%:30% may be viewed as a helpful guide. Furthermore, the Pearson's correlation coefficient for ACD ratio and tooth length was found to increase towards the midline. This supports the findings of the study by Raj, *et al.* [29].

Texture surface

Patients expect restorations to look like their natural teeth in terms of colour, shape and surface structure [45]. Tooth texture in the individuals investigated was generally smooth and shiny, as opposed to matt and rough. The female proportion for smooth and shiny was (88%) which is slightly higher than for the men (84%). This difference was not statistically significant ($p = 0.459$). The importance of this finding is that in restoring parts, or all of the labial surfaces of the maxillary anterior teeth of young adult, black, urban Zimbabweans, texturing would typically be contraindicated.

Comparative analysis

Comparative analysis between the results of the present study and a similar study on anterior tooth width, length and width/length ratios in a sample of Caucasians by Sterret and co-workers [15] failed to reveal any statistically significant differences. This was surprising as previous analyses of this type have reported consistent, systematic, significant differences, with the teeth of black individuals being significantly larger than the teeth of Caucasian counterparts [11-14,46]. This finding indicates that differences in tooth dimensions between Caucasian and black populations may be found to be variable, reinforcing the need to take a patient-centered approach to, for example, smile design procedures.

Conclusions

Notwithstanding the limitations of the present study, the findings indicate that the features of upper anterior teeth in young, black, adult, urban Zimbabweans may be found to include:

No left/right differences in tooth dimensions (width and length) of upper anterior tooth groups except for the width of the lateral incisor in males. Some gender differences in tooth dimensions, with males tending to have larger tooth dimensions than females, except for the lengths and widths of the upper lateral incisor. No gender differences in width/length ratios. The average width/length ratio percentage may be found to be slightly higher than in other ethnic groups. An absence of golden proportion ratios. A near Ideal ACD ratio. Average width and length dimensions and, as a consequence, width/length ratios similar to those reported for other ethnic groups.

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Bibliography

1. Wolfart S., et al. "Composite Images of Upper Front Teeth-Judgement of Attractiveness and Gender-Specific Correlation". *Journal of Esthetic and Restorative Dentistry* 26.6 (2014): 394-402.
2. Larsson P., et al. "Normative Values for the Oro-Facial Esthetic Scale in Sweden". *Journal of oral rehabilitation* 41.2 (2014): 148-54.
3. Wetselaar P., et al. "Psychometric Properties of the Dutch Version of the Orofacial Esthetic Scale (OES-NL) in Dental Patients with and without Self-Reported Tooth Wear". *Journal of oral rehabilitation* 42.11 (2015): 803-809.
4. Gonzalez EL., et al. "Dental Aesthetics as an Expression of Culture and Ritual". *British Dental Journal* 208.2 (2010): 77-80.
5. Henson Scott T., et al. "Influence of Dental Esthetics on Social Perceptions of Adolescents Judged by Peers". *American Journal of Orthodontics and Dentofacial Orthopedics* 140.3 (2011): 389-395.
6. Montero J., et al. "Contributions of Dental Colour to the Physical Attractiveness Stereotype". *Journal of oral rehabilitation* 41.10 (2014): 768-782.
7. Marzola R., et al. "The Science of Communicating the Art of Esthetic Dentistry. Part I: Patient-Dentist-Patient Communication". *Journal of Esthetic and Restorative Dentistry* 12.3 (2000): 131-138.
8. Tin-Oo MM., et al. "Factors Influencing Patient Satisfaction with Dental Appearance and Treatments they Desire to Improve Aesthetics". *BMC oral Health* 11.6 (2011).
9. Hansanreisoglu U., et al. "An Analysis of Maxillary Anterior Teeth: Facial and Denta Proportions". *The Journal of prosthetic dentistry* 94.6 (2005): 530-538.

10. ZAGAR M and D ZLATARI. "Influence of Esthetic Dental and Facial Measurements on the Caucasian Patients' Satisfaction". *Journal of Esthetic and Restorative Dentistry* 23.1 (2011): 12-20.
11. Bishara Samir E., et al. "Comparisons of Mesiodistal and Buccolingual Crown Dimensions of the Permanent Teeth in Three Populations from Egypt, Mexico, and the United States". *American Journal of Orthodontics and Dentofacial Orthopedics* 96.5 (1989): 416-22.
12. Keene Harris J. "Mesiodistal Crown Diameters of Permanent Teeth in Male American Negroes". *American Journal of Orthodontics* 76.1 (1979): 95-99.
13. Mack PJ. "Maxillary Arch and Central Incisor Dimensions in a Nigerian and British Population Sample". *Journal of dentistry* 9.1 (1981): 67-70.
14. Otuyemi OD and JH Noar. "A Comparison of Crown Size Dimensions of the Permanent Teeth in a Nigerian and British Population". *European journal of orthodontics* 18 (1996): 623-628.
15. Sterrett JD., et al. "Width/Length Ratios of Normal Clinical Crowns of the Maxillary Anterior Dentition in Man". *Journal of clinical periodontology* 26.3 (1999): 153-157.
16. Calcada D., et al. "Anthropometric Analysis of Anterior Maxillary Teeth with Digital Photography-a Study in a Portuguese Sample". *International Journal of Esthetic Dentistry* 9.3 (2014): 370-380.
17. Sah SK., et al. "Maxillary Anterior Teeth Dimensions and Proportions in a Central Mainland Chinese Population". *Chinese Journal of Dental Research* 17.2 (2014): 117-24.
18. Magne Pascal., et al. "Anatomic Crown Width/Length Ratios of Unworn and Worn Maxillary Teeth in White Subjects". *The Journal of prosthetic dentistry* 89.5 (2003): 453-461.
19. Araujo E and M Souki. "Bolton Anterior Tooth Size Discrepancies among Different Malocclusion Groups". *Angle Orthodontist* 73.3 (2003): 307-313.
20. Chu SJ. "Range and Mean Distribution Frequency of Individual Tooth Width of the Maxillary Anterior Dentition". *Practical Procedures & Aesthetic Dentistry* 19.4 (2007): 209-215.
21. Fattahi HR., et al. "Comparison of Tooth Discrepancies among Different Malocclusion Groups". *European Journal of Orthodontics* 28 (2006): 491-495.
22. Levin Edwin I. "Dental Esthetics and the Golden Proportion". *The Journal of prosthetic dentistry* 40.3 (1978): 244-52.
23. Preston JD. "The Golden Proportion Revisited". *Journal of esthetic dentistry* 5 (1993): 247-251.
24. SNOW STEPHEN R. "Esthetic Smile Analysis of Maxillary Anterior Tooth Width: The Golden Percentage". *Journal of Esthetic and Restorative Dentistry* 11.4 (1999): 177-184.
25. Ward DH. "Proportional Smile Design using the Recurring Esthetic (RED)Proportion". *Dental Clinics of North America* 45.1 (2001): 143-154.
26. Chu SJ and MN Hochman. "A Biometric Approach to Aesthetic Crown Lengthening: Part 1- Midfacial Considerations". *Practical procedures & Aesthetic Dentistry* 20.1 (2008): 17-24.
27. Ricketts Robert M. "The Biologic Significance of the Divine Proportion and Fibonacci Series". *American Journal of Orthodontics* 81.5 (1982): 351-370.

28. PINI NÚBIA PAVESI., *et al.* "Analysis of the Golden Proportion and Width/Height Ratios of Maxillary Anterior Dentition in Patients with Lateral Incisor Agenesis". *Journal of Esthetic and Restorative Dentistry* 24.6 (2012): 402-414.
29. RAJ VISHNU., *et al.* "The Apparent Contact Dimension and Covariates among Orthodontically Treated and Nontreated Subjects". *Journal of Esthetic and Restorative Dentistry* 21.2 (2009): 96-111.
30. Olsson M., *et al.* "On the Relationship between Crown Form and Clinical Features of the Gingivalin Adolescents". *Journal of clinical periodontology* 20.8 (1993): 570-577.
31. Gillen RJ., *et al.* "An Analysis of Selected Normative Tooth Proportions". *The International journal of prosthodontics* 7.5 (1994): 410-417.
32. CONDON M., *et al.* "Maxillary Anterior Tooth Dimensions and Proportions in an Irish Young Adult Population". *Journal of oral rehabilitation* 38.7 (2011): 501-508.
33. Kieser JA and HT Groeneveld. "Fluctuating Odontogenic Asymmetry in an Urban South African Black Population". *Journal of Dental Research* 67 (1988): 1200-5.
34. GONÇALVES LUIZ CARLOS., *et al.* "Correlation between the Individual and the Combined Width of the Six Maxillary Anterior Teeth". *Journal of Esthetic and Restorative Dentistry* 21.3 (2009): 182-191.
35. Mavroskousfis F and GM Ritchie. "Variation in Size and Form between Left and Right Maxillary Central Incisor Teeth". *The Journal of prosthetic dentistry* 43.3 (1980): 254-257.
36. Garn SM., *et al.* "Sex Difference in Tooth Size". *Journal of dental research* 43 (1964): 306.
37. Scandrett Forrest R., *et al.* "A Clinical Evaluation of Techniques to Determine the Combined Width of the Maxillary Anterior Teeth and the Maxillary Central Incisor". *The Journal of prosthetic dentistry* 48.1 (1982): 15-22.
38. Gomes Vanderlei Luiz., *et al.* "Correlation between Facial Measurements and the Mesiodistal Width of the Maxillary Anterior Teeth". *Journal of Esthetic and Restorative Dentistry* 18.4 (2006): 196-205.
39. Lombardi Richard E. "The Principles of Visual Perception and their Clinical Application to Denture Esthetics". *The Journal of prosthetic dentistry* 29.4 (1973): 358-382.
40. MAHSHID MINOO., *et al.* "Evaluation of Golden Proportion in Individuals with an Esthetic Smile". *Journal of Esthetic and Restorative Dentistry* 16.3 (2004): 185-192.
41. Rosentiel SF., *et al.* "Dentists' Preferences of Anterior Tooth Proportion- a Web Based Study". *Journal of Prosthodontics* 9.3 (2000): 123-136.
42. WARD DANIEL H. "A Study of Dentists: Preferred Maxillary Anterior Tooth Width Proportions: Comparing the Recurring Esthetic Dental Proportion to Other Mathematical and Naturally Occurring Proportions". *Journal of Esthetic and Restorative Dentistry* 19.6 (2007): 324-339.
43. KOKICH VINCENT O., *et al.* "Comparing the Perception of Dentists and Lay People to Altered Dental Esthetics". *Journal of Esthetic and Restorative Dentistry* 11.6 (1999): 311-324.
44. Morley J and J Eubank. "Macroesthetic Elements of Smile Design". *JADA* 132 (2001): 39-45.
45. Schropp L., *et al.* "Interproximal Papilla Levels Following Early Versus Delayed Placement of Single-Tooth Implants: A Controlled Clinical Trial". *International Journal of Oral and Maxillofacial Implants* 20.5 (2005): 753-761.

46. Richardson Elisha R and Shyam K. Malhotra. "Mesiodistal Crown Dimension of the Permanent Dentition of American Negroes". *American Journal of Orthodontics* 68.2 (1975): 157-164.

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