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The Correlation between Permanent Maxillary Central Incisor Crown Length, Facial Height and Body Height and Weight. An Allometric Analysis of 100 Individuals.

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Research Article

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ABSTRACT

The comparative evaluation of tooth morphometrics with facial and body parameters has been attempted in the past. That there exists a possible relation between tooth crown length, especially of the anterior teeth, and the facial and body height, has been consistently proposed. The present study aims to evaluate and statistically analyse the height of the clinical crown of the permanent maxillary central incisor with the facial height and body height of individuals involved in the study. 100 subjects (50M/50F) were included in the study. The tooth crown length was assessed from dental casts using digital vernier calipers, while the facial height and body height were physically evaluated based on established landmarks. The mean height of the maxillary central incisor clinical crown in males was 11.6mm and in females 10.5mm. The mean facial height for males was 17.67cm and that for the females was 17.16cm. The average height of the males in the study group was 180.34cm and for the females 160.61cm. The total facial height was found significantly correlated to the body height using Spearman's coefficient of variation ($r=0.283$, $p=0.004$ at $p<0.01$). There was no statistical correlation between total crown length and body height. The present study has established conclusive evidence of a statistical correlation between facial height and body height of the individual. Although no definitive correlations could be established between total crown length and body height, the use of the established parameters will be helpful in the fields of forensic odontology and anthropology.

INTRODUCTION

The determination of body parameters is an integral part in the identification of an individual. Teeth morphometrics have been invaluable in this regard and the dimensions of a tooth have often been correlated to body stature. Various studies have been conducted in the past to attempt correlations between tooth shape and size with body structure. Sterrett JD et al [1] attempted to correlate the width/length ratios of the maxillary anterior teeth of Caucasians to the height of the individual and could not find any statistical significant correlation. Jaywardena CK et al [2] attempted a similar study in Sri Lankan Sinhalese individuals and came to the similar conclusion that tooth morphometrics do no determine body height of the subject. On the other hand Prahbu S et al [3] evaluating multiple dimensional parameters of the maxillary central incisor tooth found a small, albeit statistically significant correlation to the body height.

The confusion in the results of the previous studies is attributable probably to two factors: the choice of parameters in the tooth dimensions and ethnic configurations. Multiple parameters tend to confuse issues and are more an attempt to seek out a correlation between tooth morphometry and body height. Ethnic and racial differences invariably play a part in the assessments due to the variations in tooth and body size.

The present study aims to establish a relation, if any, between the crown length of the permanent maxillary central incisor tooth and the facial height and body height of the individual. It is hypothesized that a comparison between the three parameters is reflective of the body stature of an individual and any statistical correlation will help in extrapolating the ratios that may helpful in determining allometric parameters of the individual.

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MATERIAL AND METHODS

The study group comprises of 100 subjects (50M/50F) aged between 18-23 years considering the fact that this age group has minimal attrition.

The inclusion criteria were:

- Full set of dentition of maxillary and mandibular arch up to 2nd molar;
- Healthy periodontium.
- No interdental spacing or crowding.
- No restorations on the permanent maxillary central incisor teeth.
- No history of orthodontic treatment.

The exclusion criteria are

- Evidence of gingival alteration or dental irregularities.
- Apparent loss of tooth structure due to attrition, fracture, caries, or restorations;
- Individuals presenting any characteristics which could alter the contour of the face and dentition.

Following informed consent, basic body parameters like age, height and weight were recorded. Direct facial measurements were obtained from each student while he/she was sitting in upright position with his/her teeth in centric occlusion, lips relaxed and with unsupported head, looking straight ahead to maintain natural head position. The height of the subject was recorded using a standard wall attached height scale.

On the face, proposed landmarks were established by using erasable markers, and the measurements were obtained using inelastic thread and later transferred to a standardized long metallic ruler to calculate the distance. Table I elaborates the proposed landmarks used for determining facial height. Standard facial photographs were taken of each subject in the frontal and lateral view using a Canon EOS 500 8megapixel digital camera attached with a ringflash. Superimposition of the landmarks was done in both the views.

For tooth measurements impressions of the upper arches were made using irreversible hydrocolloid (alginate) material and dental stone casts of the same were obtained. Landmarks were marked using proposed standard points as elaborated in Table 1. Calibrations were recorded using digital vernier calipers (Aerospace Ltd, Bangalore). Both the facial and the dental measurements were transferred on to a MS EXCEL sheet and subjected to statistical analysis (SPSS version 15).

Statistical Methods

Spearman's rank or rho correlation test was used for measuring the statistical dependence between the parameters. This test assesses how well the relationship between two variables can be described as a monotonic function. If there are no repeated data values, a perfect Spearman correlation of +1 or -1 occurs when each of the variables is a perfect monotone function of the other.

RESULTS

5 landmarks on the frontal portion of the face and 2 landmarks on the labial surface of the permanent maxillary central incisor were identified for establishment of the facial height and the tooth crown length respectively (Table 1). The landmarks that were identified included both hard and soft tissue. In the frontal profile the horizontal parameters of facial height were further subdivided into upper, middle and lower one-third and a sum of the three was computed as the total facial height.

The average height of the subjects in the study was 180.34 cm for males and 160.61cm for females respectively. The average male weighed 62.57kg and the female 61.26kg. The total facial height (TFH) of the males and females did not differ considerably with mean TFH in males being 17.67cm and those in females recorded as 17.16cm. The composite TFH of the group was 17.41cm. The mean total crown length (CL) of the central incisor in males was 1.22cm and those in females was 1.10cm. The composite crown length of the group was 1.10cm (Tables 2,3,4). The total facial height was subdivided into upper one-third (UFH), middle one-third (MFH) and lower one third (LFH). LFH was found to be most pronounced (6.65cm) followed by MFH (6.06cm) and the least was the UFH (4.70).

Statistically Pearson correlation indicated a significant relation between the body height (BH) and the facial height (TFH) (r=0.283, p=0.004). No statistical correlation could be detected between the crown length of the tooth and the height of the individual (r=-0.014, p=0.893). When the correlation was done individually in males and

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females, only in males the facial height and body height was significantly correlated (r=0.33, p=0.019) (Table 5). No gender correlation existed of body height with any of the other two parameters.

Table 1: Landmarks used for determination of facial height, tooth crown length and body height.

	Landmarks	Parameters
	Facial height (Frontal/Vertical Profile)	
1.	Midpoint of line joining right and left frontal prominence to midpoint of glabella	Upper Facial Height (UFH)
2.	Midpoint of Glabella to tip of nose	Middle Facial height (MFH)
3.	Midpoint of upper lip philtrum to midpoint of chin (menton)	Lower Facial height (LFH)
4.	Combination of the above	Total Facial Height (TFH)
	Tooth Crown Length	
1.	Line joining midpoint of incisal edge and the cervical edge	Total Crown Length (TCL)

Table 2: Composite average measurements of all the parameters of males and females in tooth parameters and age, height and weight.

	Age(yrs)		Height (cm)		Weight (KG)		Total Facial height (TFH) (cm)		Total Crown Length (CL) (cm)	
	M	F	M	F	M	F	M	F	M	F
Number	50	50	50	50	50	50	50	50	50	50
Mean	21.20	22.23	180.34	160.61	62.57	61.26	17.67	17.16	1.22	1.10
Median	21.00	24.56	172.72	179.65	59.57	58.50	17.80	16.28	1.06	1.05
SD	2.261	2.70	63.5	56.05	16.56	15.779	1.60	6.62	16.25	1.20

Table 3: Composite measurements of facial height and tooth crown length in the Subjects

	UFH*	MFH*	LFH*	TFH*	CL*
Number	100	100	100	100	100
Mean	4.70	6.06	6.65	17.41	1.16
Median	4.20	6.20	6.50	16.90	1.05
SD	3.83	0.95	0.70	5.48	11.52

UFH-Upper Facial height, MFH-Middle Facial height, LFH-Lower Facial height, TFH-Total facial height, CL-Crown length

Table 4: Correlation of parameters total facial height, individual body height and clinical crown height.

		Clinical crown height	Individual body height
Face height	Pearson corelation	-0.013	0.283
	Sig.(2tailed)	0.898	0.004
	Number	100	100
clinical crown height	Pearson corelation		-0.014
	Sig.(2tailed)		0.893
	Number		100

Table 5: Correlation between facial height, clinical crown height and individual body height for both males and females combined together.

Gender			Clinical crown height	Individual body height
Female	Facial height	Pearson correlation	-0.150	-0.041
		Significance(2- tailed)	0.297	0.778
		N	50	50
	Clinical crown height	Pearson correlation		-0.032
		Significance(2 -tailed)		0.824
		N		50
Male	Facial height	Pearson correlation	0.077	0.330
		Significance(2- tailed)	0.596	0.019
		N	50	50
	Clinical crown height	Pearson correlation		0.054
		Significance(2- tailed)		0.709
		N		50

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Table 6: Comparative analysis of previous studies correlating tooth crown length with facial height and body height [1-7].

	Author	Target	Sample Size	Av crown ht	Av body ht (cm)	Facial Height	Result
1.	Jayawrdena CK et al 2005	Humans (Sri Lankan Sinhalese)	135 (33M/102F)	M-10.67 F-10.79	M-162.11 F-148.91		No correlation
2	Sterett JD et 1999	Humans (Caucasians)	71 (24M/47F)	M-8.59/ F-8.06	M-181.2 F -164		No correlation
3.	Prabhu S et al 2013	humans	95 (48M/47F)	BL/MD dimensions taken	-		21 of 56 variables had low statistical correlation
4.	Kulkarni N, Kohli M 2011	Humans (Indians)	1000 (500M/500F)		161-170cms	17-19cms	No correlation
5.	Prasanna LC et al 2013	Humans (Indians)	200 (100M/100F)		North Indian (M=173.25cm/F=156cm) South Indian (M=170.6cm/ F=157cm)	North Indian (M=12.36cm/ F=11.7cm) South Indian (M=11.97cm/F= 10.10cm)	Statistically correlated and subject height derived from facial height.
6.	Wankhede KP et al 2012	Humans (Central Indian population)	470 (M=270/F=210)		M=170.97cm /F=156.89cm	M=11.43cm/F= 10.66cm	Correlation in males
7.	Wood BA 1979	5 primate species (Homo, Gorilla, Pan, Papio, Colobus)	-	-	-		Tooth and femur length (ht) more in homo species

DISCUSSION

It is generally acknowledged that there is a possible relationship between the tooth dimensions and body size. Various studies in the past have dwelt on this issue with differing results. The dimensions of a tooth are evolutionary determined and subject to influences of environmental factors. Similar to the growth of a human being influenced by genetic factors and his surroundings the growth of a tooth is proportional to the influences of race and ethnicity. In proportion to the body growth it is assumed that the facial growth and tooth development follows a pattern. The stature of an individual may be defined as "the natural height of the human or animal in upright position". The relation between tooth height (crown length), facial height and body height is therefore interesting to assess features that may indicate the pattern of growth and identification of the person. Jaywardena CK et al [2] attempted to correlate the tooth length (crown and root length) with body height in Sri Lankan Sinhalese and found no statistical relationship between the two parameters. Sterrett JD et al [1] analysed the width/length ratios of maxillary anterior teeth and tried to determine a relationship with the subject height. No definite correlations were found between height of the individual and height of the tooth though the authors did find internal statistical correlations between male and female heights and the width/length ratios.

The present study also showed similar results. No statistically significant correlations were obtained between crown length and the subject height. The overwhelming evidence is pointing to the fact that the development of the tooth in the vertical direction is independent of the height of the individual. This is a strong justification of interplay of genetic and environmental factors being specific to the dermatomal development of the region. Interestingly in another study, Prabhu S et al [3] analysed buccolingual and mesiodistal dimensions of human teeth (except third molars) in 95 individuals and found 21 out of 56 tooth variables weakly statistically significant when compared with stature of the individual. The significant part of this study was the use of buccolingual and mesiodistal dimensions of a tooth rather than the vertical as was done for most previous studies. The involvement of almost the entire dentition makes this exercise rather confusing and the results probably justify this conclusion.

We detected a statistically significant relationship between facial height and subject height in our study. When gender discrimination was analysed, males showed a statistically significant relationship to their stature as compared to females. Kulkarni N et al [4] found no statistically significant relationship in their study comparing facial height to body height. They observed overall increased total facial height in males but found the deviation of lower facial height more in females and used it to signify prediction of total facial height. In an analysis of 200 individuals Prasanna LC et al [5] found a definite statistical correlation between facial height and stature. They compared the facial indices, facial height and stature in North and South Indian males and females and came to the conclusion that stature could be derived from facial height using multiple regression analyses. A similar correlation in males was found in astudy involving 470 individuals in Central India [6]. The overwhelming evidence points to use of facial height as a dependable parameter in relation to body height of an individual.

The use of the crown length of a tooth to determine the body length has been used extensively in anthropology. Wood BA [7] investigated the strength of covariance between tooth and body size in five primate taxa Homo, Pan, Gorilla, Papio and Colobus. The author noted that allometry coefficients for each variable were not uniform among the taxa and coefficients differed from variables. Though the observations in the four non-human taxa were different than the only human taxa Homo included in the study, no specific correlations could be derived of body size from tooth size. Shimada K [8] analysed anatomically the teeth of great white sharks and proposed a linear relationship between tooth crown height and total body length. This relationship is expressed as: total length in cms = a + bx where a is a constant, bis the slope of the line and x is the crown length of the labial surface of the tooth. This a popular formula used by anthropologists and palaentologists for measuring body length of sharks. The applicability of this formula to humans has not yet been evaluated. Table 6 lists a comparative analysis of the use of the parameters tooth height, facial height and body height gleaned from literature till date.

In summation it is increasingly evident that tooth crown length is an unreliable predictor of body height while the parameter of facial height seems highly variable. Larger studies with more subjects may probably clarify the significance of these parameters.

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