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Prediction of Anthropometric Measurements from Tooth Length – A Dravidian Study

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The authors declare that they have no conflict of interest.

ABSTRACT

Background: Anthropometric measurement is essential for identification of both victims and suspects. Often, this data is not readily available in a crime scene situation. The availability of one data set should help in predicting the other.

This study was hypothesised on the basis of a correlation and geometry between the tooth length and various body measurements.

Aim and objective: To correlate face, palm, foot and stature measurements with tooth length. To derive a regression formula to estimate the various measurements from tooth length.

Materials and methods: The present study was conducted on Dravidian dental students in the age group 18 - 25 with a sample size of 372. All of the dental and physical parameters were measured using standard anthropometric equipments and techniques.

Results: The data was analysed using SPSS software and the methods used for statistical analysis were linear regression analysis and Pearson correlation. The parameters (incisor height (IH), face height (FH), palm length (PL), foot length (FL) and stature (S) showed nil to mild correlation (R = 0.2 ≤ 0.4) except for palm length (PL) and foot length (FL). (R>0.6).

Conclusion: It is concluded that odontometric data is not a reliable source for estimating the face height (FH), palm length (PL), foot length (FL) and stature (S).

***KEYWORDS*:** tooth length, face length, palm length, foot length, height, Dravidians

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INTRODUCTION

Anthropometry comprises a series of systematized measuring techniques that expresses quantitatively the dimensions of the human body including skeletonised remains. It is a highly objective and reliable technique that can be used for the identification of individuals linked to a crime scene. Somatometry, cephalometry, craniometry and osteometry are the different tools used in anthropometry and these tools been proved to be valid in the identification of human remains[1]. Anthropometric difference varies between races and is influenced by national social and economic conditions[2]. The major races of the world population are broadly categorized as Caucasian, Mongolian, Negroid or Austroloid[3]. Indians belong to a Caucasian sub-group termed Indo-Dravidian. India is a diverse country with varied races including Aryans, Dravidians and Mongolians[4,5].

Knowledge relating to variation in the dimensions of the human body is important in not only in medico-legal identification but is also helpful in plastic surgery, prosthetic replacement and cancer research[6]. Teeth are the least destructible component of the body and can survive extreme environmental insult. In some circumstances dental anthropometric data can be used when other forensic data are not available; measurements of erupted teeth are comparable with other skeletal dimensions[7].

Despite numerous published anthropometric studies very few studies addressed the correlation of dental and physical anthropometric measurements of Dravidians. Against this background the hypothesis of this study is; "There is a correlation and geometry between the tooth length and various body measurements[6]. It is established that the skin, the hair, head form, face form, the nose, the eyes, the stature and dentition are distinguishing and unique features for each race[8]. This study uses physical and dental anthropometric tools to compare data and to derive a regressive equation for the Dravidian population.

MATERIAL AND METHODS

This study was a cross-sectional study including 372 subjects aged between 19 to 23 years. 83 subjects were male & 289 subjects were female. All of the samples were obtained from Dravidian dental students with single ancestral origin. Ethical clearance was obtained from the institution. The details of the study were explained and written informed consent was obtained from each student agreeing to participate in the study. Participants with any kind of deformity, either congenital or acquired, were excluded. A pre-requisite for inclusion in the study was good periodontal health. The five parameters included in the study were stature (S), palm length (PL), foot length (FL), face height (FH) and incisor height (IH).

Stature (S) was measured in a standing position to the vertex in Frankfurt plane by using an anthropometric rod. Total facial height (FH) was noted as the distance between the nasion and the gnathion and measured using a vernier caliper. For foot length (FL) and palm length (PL) the foot and palm were moistened with surgical spirit and placed on a large ink pad making sure that the palm and foot were fully extended. The left foot and palm were taken to maintain uniformity.

The palm length (PL) was measured as the distance between the interstyloid line and tip of the middle finger which was recorded by using an ink pad.

The foot length (FL) was recorded as the maximum length between most prominent posterior part of the heel and tip of second toe. A divider was used to measure the length and the findings were recorded in centimetres.

The incisor height (IH) was measured with a divider as the maximum distance between the marginal gingiva and incisal edge. The results were statistically analysed and correlated with multiple linear regression using the method of Pearson.

RESULTS

The odontometric parameter incisor height (IH) was compared to all other parameters including facial height (FH), palm length (PL), foot length (FL) and stature (S). Firstly IH and FH were compared and correlated (Fig. 1, Table 1& 5).

A variation of 0.069 obtained. The regression equation was found to be FH = 14.176 + 2.264 x IH. IH and PL were compared and correlated (Fig. 2, Table 2& 5). A mild variation of 0.023 was obtained; the regression equation was found to be PL = 15.699 + 1.379 x IH.

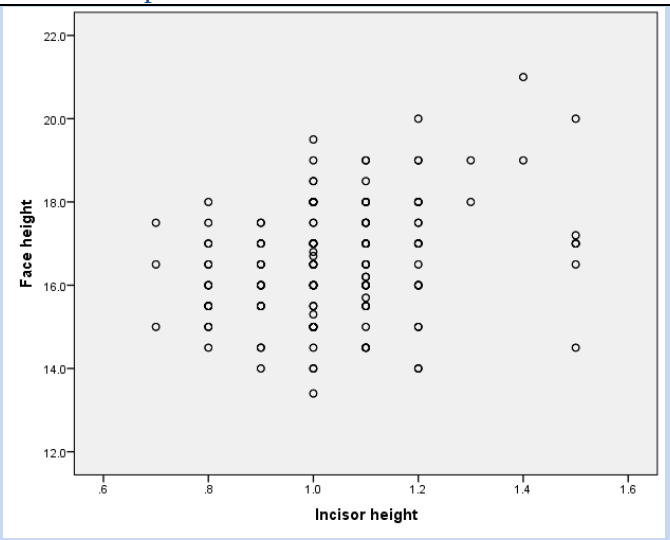

Fig.1: Correlation between incisor height and face height (measurement in mm)

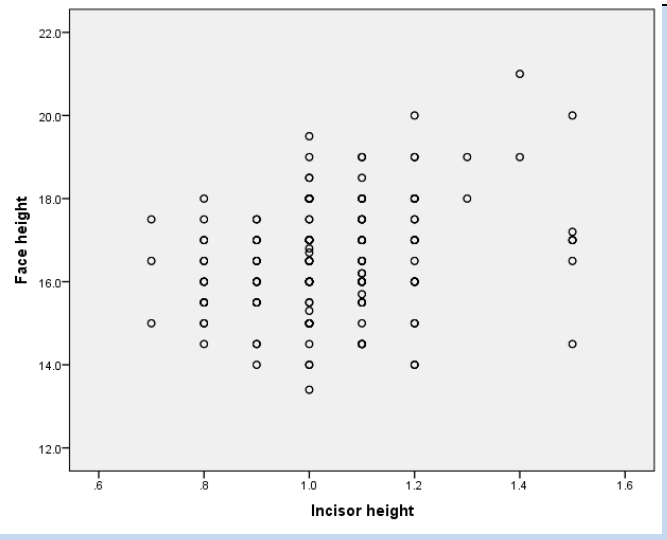

Fig.2: Correlation between incisor height and palm length (measurement in mm)

Fig. 3, shows the comparison and correlation between the IH and FL with a variation of 0.034; the regression equation was found to be being FL = 19.640 +

3.092 x IH. This demonstrates that there is only mild correlation between IH and FL.

that there is only a mild correlation between the parameters. The regression equation was found to be S = 141.153 + 19.828 x IH.

Fig. 4, reveals the comparative variable for IH and S to be 0.061. This demonstrates

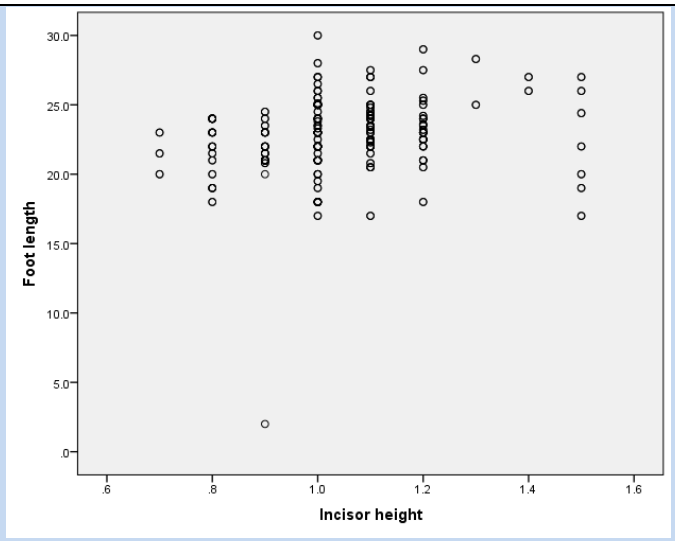

Fig.3: Correlation between incisor height and foot length (measurement in mm)

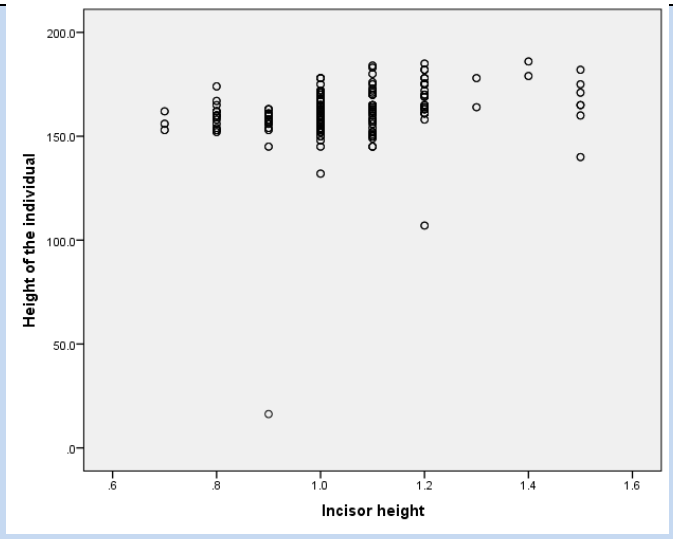

Fig.4: Correlation between incisor height and foot length (measurement in mm)

Table 1: Linear regression equation for various parameters from incisor height (measurement in mm)

Parameter	Unstandardized Coefficients		Standardized Coefficients	t-Value	P-Value	95.0% Confidence Interval for B		Regression Equation
	B	Std. Error				Lower Bound	Upper Bound	
Constant	14.176	.454						Face height = 14.176 + 2.264 × Incisor height
Incisor Height	2.264	.43 1	.263	5.251	<0.001	1.416	3.112	
(Constant)	15.699	.492						Palm length = 15.699 + 1.379 × Incisor height
Incisor height	1.379	.467	.152	2.955	0.003	.461	2.297	
(Constant)	15.699	.492						Foot length = 19.640 + 3.092 × Incisor height
Incisor height	3.092	.854	.185	3.621	<0.001	1.413	4.771	
(Constant)	141.153	4.261						Height = 141.153 + 19.828 × Incisor height
Incisor height	19.828	4.045	.247	4.902	<0.001	11.874	27.783	

Table 2: Correlation between all the parameters of the study

		Face height	Palm height	Foot length	Height of the individual
Incisor height	Correlation	0.263	0.152	0.185	0.247
	P-Value	<0.001	0.003	<0.001	<0.001
	N	372	369	370	372
Face height	Correlation		0.451	0.371	0.342
	P-Value		<0.001	<0.001	<0.001
	N		369	370	372
Palm height	Correlation			0.623	0.416
	P-Value			<0.001	<0.001
	N			369	369
Foot length	Correlation				0.411
	P-Value				<0.001
	N				370

DISCUSSION

It is generally accepted that Crime Scene Investigators consider dental records to be of reliable evidential value. It has been stated that the dentition and jaw pattern of an individual are unique and that tooth measurements can used to assist in the identification of a suspect or victim. Anthropometry can play an important role in catastrophic events such as fire where the teeth and bones may be discovered that represent the sole remnants of the victim [5, 6]. In most cases medico-legal investigators have access to some odontometric data and, in some cases, such as described above, this may prove to be the only source of relevant data for purposes of identification [7].

It has been postulated that stature can influence tooth height since it has an impact on face height. Human body parts have been shown to correlate with stature and biologic measurements are unique for the species Homo sapiens. A number of factors including age, race, gender and nutritional status affect human development and growth. These factors can differ, sometimes drastically, between different races [8]. There are numerous studies published in the literature designed to estimate stature from arm, leg, foot and finger measurements. One conclusion from the studies was that geometry existed

between the stature and the extremities, the head, the trunk and the vertebral column [6]. Currently a lacunae of similar studies exists in Dravidian populations. The present study was formulated to predict the palm length (PL), foot length FL), facial height (FH) and stature (S) from incisor height and to correlate the parameters.

In the present study on correlating IH with FH, the variation factor was 0.069 indicating a nil correlation between incisor height and face height The regression equation was found to be FH = 14.176 + 2.264 x IH (Graph 1,Table 1). Taller people do possess long teeth that contribute to an increase in face height. However the correlation between face and tooth dimension remains controversial. In a study by Arthur et al the ratio of incisor length and facial height was found to be 1:16 [9]. The results of the present study are not in accordance with this figure.

Comparison of IH and PL revealed only a mild variation (r = 0.023) with a regression equation of PL = 15.699 + 1.379 x IH (Graph 2, Table 2). Kamel et al (1990) concluded that palm length alone can attribute in estimating stature and not the palm width [10]. Further research is needed to establish whether IH and PL can be correlated.

Correlation of IH and FL resulted in a variation factor of 0.034; the regression equation was found to be FL = 19.640 + 3.092 x IH (Graph 3,). This demonstrates only mild correlation between the IH and FL. Previous studies have demonstrated positive correlation between height and long bones which is in accordance with an African research work done in children [11]

In the present study no association was demonstrated between IH and S (r=0.061) meaning only mild correlation between the parameters. The regression equation was found to be S = 141.153 + 19.828 x IH (Graph 4, Table 4&4A). This result is in agreement with two previous studies, one based on individuals from Sri Lanka [12] and the other on individuals of Caucasian race [13]. Ozaki et al [14] reported that there exists a possible correlation between tooth length and stature. However the study of Ozaki [14] was based on total tooth length including the lengths of both the crown and the root. In their study of an Afro-American population Henderson and Corruccini infer that only mesio-distal and bucco-lingual tooth parameters can predict stature height [15]

In the present study comparison of the anthropometric parameters demonstrated strong correlation between FL and PL of 0.623. This was statistically significant with a P value less than <0.001. This suggests that the PL can be derived from FL and vice versa. Although a significant P value was obtained when comparing the other parameters, the correlation was found to vary from nil to moderate and this can be attributed to the large sample size. This fact is contradictory to the previous research results by Kamel A et al [10], Krishnan et al [4] and Khanapurkar et al [16]. All of these studies conclude that the hand and feet parameters are reliable sources to derive stature estimation. The study of Stanley et al [17] correlated tooth size with body size and included several different races and species. The findings of this study yielded nil correlation and these findings are in accord with the findings of the present study.

Further research is proposed in an attempt to explore the current finding of minimal correlation between the anthropometric parameters. The present study relied on measurement of the clinical height of the incisor tooth. Future studies will investigate the anatomical height of the incisor facilitated by the use of radiographs.

CONCLUSION

It was previously assumed that from incisal height (IH) other parameters including facial height (FH), palm length (PL), foot length (FL) and stature (S) could be

determined. However the present study demonstrated minimal correlation between the anthropometric parameters. It is suggested that incisor length is not validated in predicting the other biological measurements in the Dravidian population. It is likely that the palm length (PL) can be estimated from the foot length (FL).

Against this background the authors of this study suggest that incisor height (IH) is not a reliable data source to predict/derive other anthropometric parameters. These parameters include facial height (FH), palm length (PL), foot length (FL) and stature (S). Odontometry cannot be used to predict facial height (FH), palm length (PL), foot length (FL) and stature (S).

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