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Original Research

Prediction of Body Weight and Body Mass Index from Tooth Crown Area: A Preliminary Study

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***Abstract*:**

Background: Natural catastrophes account for maximum and most undesirable loss of mankind. Those individuals can be best represented by dental remnants. Body size is probably the single most important determinant of body architecture, physiology ecology, life history, and social organization in mammals. The weight and body mass index (BMI) can be used as a measure of body size. It is seen that the tooth crown area (crown length multiplied by crown width) increases in relation to the square of a linear dimension, whereas body weight, being proportional to volume, increases in relation to the cube of a linear dimension, assuming geometric similarity is maintained. Thus, one might predict theoretically that tooth area should increase or decrease as the 2/3 (or 0.67) power of body weight. BMI can be calculated from body weight and height of an individual. In this study, we tried to examine the relationship between tooth crown area and body weight and BMI of human individuals. To correlate the relationship of tooth crown area with body weight and BMI of human beings.

Materials and Methods: Study includes 60 individuals (30 males and 30 females) of 18-24 years of age group. Tooth crown area will be calculated as mesial-distal crown length multiplied by buccal-lingual width (L × W). Weight of individual will be recorded in grams. Height of individual will be recorded in centimeters. BMI will be calculated. Tooth crown area will be correlated with body weight and BMI.

Results: A positive relationship between total crown area and body weight as well total crown area and BMI was observed.

Conclusion: Tooth size and body size can be correlated in living human individuals. One can use the tooth crown area to predict the weight and BMI of an individual.

Key Words: Body mass index, body weight, total crown area

Introduction

Body size is probably the singles most important determinant of body architecture, physiology ecology, life history, and social organization in mammals.[1] The deceased individuals are many of times are best represented by dental remnants. A number of authors have investigated the relationship of tooth size to body size in mammals using skull length, femur length, or head and -body length as a measure of body size.[2-9] Hence, it is important to understand how tooth size is related to body size to reconstruction of deceased individual.

There are at least three distinct ways that the relationship of tooth size to body size is important:

1. Functional inference: Physiologic requirements of individual, changes in predictable ways as body size changes and one-way to study the functional significance of characteristics like tooth size is to examine how it changes in relation to body size and coordinated physiological changes
2. Baseline comparison: A clear understanding of the common or general relationship of tooth size to body size permits one to identify outliners that require different and special functional explanation
3. Prediction of body mass: Body mass is a powerful predictor of diet and other life history parameters in living individuals, and tooth size can be used to estimate body size in hard tissue remnants, providing access to more complete reconstruction of the biology of individual than would otherwise be possible.

We use body weight and body mass index (BMI) as our measure of body size because, among the measures most commonly used, this quantity facilitates comparison among individuals of different head- and body-shape. Various studies of body weight prediction using Total crown area (TCA) have been done in fossils and living primates.[10] However, no such studies have been carried out in human beings. Here, we want to correlate the relationship of tooth crown area with body

weight and BMI of human individuals.

Aims and objective

1. To correlate the tooth crown area (TCA) of the permanent mandibular first molar with the body weight of the individual
2. To correlate the tooth crown area (TCA) of the permanent mandibular first molar with the BMI of the individual.

Materials and Methods

The present study included 30 males and 30 females from age group of 18 to 24 years. The mandibular alginate impressions were recorded for each individual. The cast was prepared with dental stone (Figure 1a and b). Then, mesiodistal (length of crown) and buccolingual (breath of crown) width of the permanent left mandibular first molar was measured in millimeters with digital Vernier Caliper (Figure 2a and b). Tooth crown area (TCA) of right mandibular first molar was calculated from the Formula No: 1 and it was considered our measure of tooth size which is expressed in mm^2.

Formula No: 1

$$TCA = (\text{Length of Crown}) \times (\text{Breath of Crown})$$

The height of individual was measured in centimeters and weight of each individual was measured in kilograms (Figure 3a and b). BMI was calculated by Formula No: 2.

Formula No: 2

$$BMI = (\text{Body weight}) \div (\text{Height}^2)$$

Exclusion criteria

1. Individuals with any systemic diseases which would affect the development of individual
2. Female individuals studied should not be pregnant
3. Tooth with any pathology such as caries, periodontitis, regressive changes which would alter the surface area of the tooth
4. Tooth with any prosthetic fittings
5. Mal-aligned teeth.

Results

The data obtained were analyzed using Karl-Pearson correlation coefficient to determine the relationship between TCA and body weight; TCA and BMI. The results are presented in the Table 1. We found a positive relationship between TCA and body weight as well TCA and BMI, Thus, as TCA increases, body weight and BMI also increases.

Discussion

Reconstructive identification of a deceased individual is undertaken when circumstantial evidence may not give an indication about the putative identity of the deceased and consequently, dental records are not traceable. This could be the case in dental/skeletal remains and warrants building a post-mortem profile for reconstructive identification.

Tooth crown area (crown length multiplied by crown width) increases in relation to the square of a linear dimension, whereas body weight, being proportional to volume, increases in relation to the cube of a linear dimension, assuming geometric similarity is maintained. Thus, one might predict

Figure 1: (a and b) Armamentarium required for recording impressions of the individuals and preparation of cast.

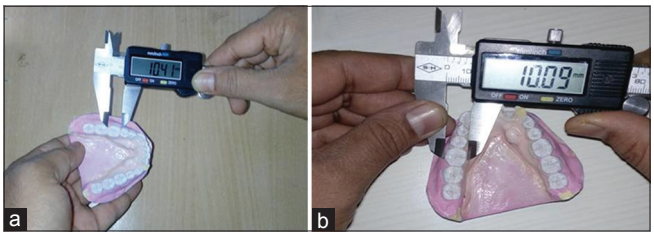

Figure 2: (a and b) Measuring of mesio-distal width of left mandibular first molar and measuring of bucco-lingual width of left mandibular first molar.

Figure 3: (a and b) Measuring of height and weight of an individual in centimeters and kilogram, respectively.

Table 1: Relationship between (i) TCA and body weight (ii) TCA and BMI – Analyzed using Karl-Pearson correlation coefficient.

Pair	Mean	SD	Correction coefficient	% Relationship	Remark
TCA	117.0208	12.6824	0.1662	16.62	Positive relationship
Body Weight	72.15	16.4986			
TCA	117.0208	12.6824	0.2433	24.33	Positive relationship
BMI	23.93	4.3852			

BMI: Body mass index, SD: Standard deviation, TCA: Tooth crown area

theoretically that tooth area should increase or decrease as the 2/3 (or 0.67) power of body weight. This is the "geometric scaling" model - the model that describes how area and volume are related if geometric similarity is maintained.[10]

Alternatively, one might expect tooth crown area, being directly involved in feeding and hence metabolism, to conform to metabolic scaling, which is proportional to the ¾ (or 0.75) power of body weight. This is the "metabolic scaling" model - The model that describes how area and volume are related if area scales in proportion to metabolism.[11,12]

Gingerich[13] used second molar length and body weight to test the correlation between tooth size and body size in living hominoidea. These variates are highly correlated ($r = 0.942$, $P < 0.001$), indicating that tooth size can be used in dentally unspecialized fossil hominoids as one method of predicting the average body weight of species. Here, we used TCA of permanent mandibular first molar and body weight to test the correlation between tooth size and body size in living humans.

Cochard[14] investigated the relationship between post-canine occlusal surface area, body size in female primates and found the degree of female dental enlargement is most closely related to degree of sexual dimorphism in body weight. Martin using summed posterior area on a skeletal collection of 27 gorillas (15 males and 12 females) demonstrated signifi cant correlations between summed posterior areas of maxillary teeth (P3-M3) and body size. She used the sum of humerus and femur length, summed minimum crosssectional area and the summed volumes of the humerus and femur to represent body size.[15]. She used the sum of humerus and femur length, summed minimum cross-sectional area and the summed volumes of the humerus and femur to represent body size. In the present study, we used a single tooth area as a measure of tooth size because it is a very difficult that all the multiple posterior teeth are conserved in comparison with a single tooth in a deceased individual.

Tooth crown area is a compound measure that has several advantages over either of length or width alone. Crown area is based on two independent (orthogonal) measures of the same tooth, yielding a more accurate measure of tooth size than that given by any single measurement. Gingerich has shown that tooth size, particularly mandibular first molar area, is a good estimator of body size within a group of related mammals spanning a significant range of body sizes.[16] BMI is ultimately concerned with the dietary habit of the individual, and persons dietary habit will affect the morphology of the mandibular first molar which is the prime tooth bearing the masticatory forces. In the present study, we can interpret that the BMI of an individual can be correlated with the TCA of permanent mandibular first molar. However, body weight also correlated positively with the TCA of permanent mandibular first molar. So by employing this study on a large cohort, we can predict the BMI from TCA of the permanent mandibular first molar crown.

The body weight of the individual can be derived from the BMI and height of the person (from other parameters like femur length, sternal length). Most of the information during dental profiling aim at determining the ethnicity, age, and gender of the individual, therefore, the physical profile of the deceased is not easily discernable with the information obtained. This study is an attempt to reach the goal in defining the physical profile of a deceased individual from dental hard tissue remnants and thereby filling a void in reconstructive personal identification.

Conclusion

Tooth size and body size can be highly correlated in living human individuals. This correlation can be used to predict average body weight and BMI from dental dimensions for deceased individuals which could help for the reconstructive identification of an individual.

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