Original Article

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Association of Primary Tooth Metrics and Body Mass Index Among Chennai Children

Ashwini Shenai[1], Deepa Gurunathan[2]

Abstract

Introduction: Tooth morphometrics show variations across gender, phenotypes, race, age and populations. These variations are evolutionarily determined but maybe modified by environmental factors such as socioeconomic conditions, nutrition, childhood health, maternal effects such as gestation and systemic conditions. Despite strong genetic contribution, the tooth may fail to reach its maximum potential size due to the role of environmental influences. A relation between tooth size and body size would compound the notion that teeth size, though dependent on genetic contribution, are not insulated from external influences. Previously attempts to corelate tooth size and body size by other authors have shown differing results. There is also a dearth of information regarding the same on deciduous dentition. Hence this study aims to corelate Body Mass Index (BMI) and clinical crown length (CL), mesiodistal width (MDW) and buccolingual width (BLW) of primary maxillary canines and first molars, among Chennai children. *Materials and methods:* A cross-sectional study was conducted among 100 school going children, of both genders, in the age group of 3-6 years. Weight and height were calculated by metric standards and BMI was obtained. The participants were grouped as healthy, underweight and overweight. The different groups were measured intraorally, with a digital Vernier caliper for crown lengths, mesiodistal and buccolingual widths of primary upper canines and molars. Data was statistically analyzed. *Results:* Total of 49,22,18 belong to healthy, underweight and overweight. Comparison of the mean (SD) of CL, MDW, BLW of upper primary canine and first molar among participants of different body size using one-way ANOVA test was found to be statistically significant ($P<0.05$). *Conclusion:* A positive correlation exists a between body mass index and tooth metrics. Evident deciduous crown size variations of individuals of different BMI belonging to the same population should be taken into consideration while studying population comparisons of different odontometric standards.

Keywords: Morphometrics, Body Mass Index, Crown length, Mesiodistal width, Buccolingual width

Introduction

Quantitative analysis on size and shape of teeth, or Odontometrics, are frequently used in anthropology, archeology, dentistry and forensic dentistry [1]. They have provided as a means of clinical study material on living as well as non-living populations. There are abundant studies in literature on tooth size measurements, as teeth provide valuable data on phylogeny and ontogeny [2]. Within a forensic context, teeth make ideal candidates in times of identification crisis due to their resistance to natural agents such as fires. Teeth act as stable anatomical landmarks; well defined, easy to locate, and with parameters that remain stable over time. Odontometric data have been useful to geneticists to study heritability in size and chromosomal influences and to pedodontists to understand normal and abnormal occlusion, and tooth-jaw size discrepancy, among others. In addition to this, these data are of great value to anthropologists who compare odontometric variations with a historical and evolutionary perspective, given that variations in tooth size can

Author's Affiliation: [1]Graduate Student, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu 600077, India. [2]Professor, Department of Pedodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu 600077, India.

Corresponding Author: Deepa Gurunathan, Professor Department of Pedodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu 600077, India.

E-mail: drgdeepa@yahoo.co.in

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be correlated with different populations, customs, lifestyles and eating habits.

There exists a wealth of evidence to support the fact that these odontometric measurements show variations across the globe. It is a well acknowledged that variability in tooth morphometrics exists between genders and plays a significant role in the identification of an individual [2,3,4]. There is also noted variation among different age groups, phenotypes and populations [5,6,7].

Studies have revealed that variations in tooth metrices are determined by genetic factors, but maybe influenced by environmental factors such as nutrition, gestational conditions and childhood health. Just as the growth of the body is influenced by genetic factors and the individual's surroundings, the growth of teeth is thought to be similarly influenced. This implies that, despite strong genetic contribution, the tooth may fail to reach its maximum potential size due to the role of environmental influences [8].

The difference in patterns of tooth size are thought to reflect difference in contribution of environmental and genetic factors to their contribution. Moreover, odontometric parameters show a difference in specific populations and even within the same population [9]. There exists a need to establish normative data with specificity in regards to region and population.

A possible relation between tooth size and body size has been explored in different studies previously. Body size has been touted as the single most important determinant of body architecture, physiology, ecology, evolutionary history and social organization in mammals [10]. Studies have attempted to corelate tooth size to body size in mammals using length of the skull, femur and head and body length as a measure of body size [11,12]. A relation between tooth size and body size would compound the notion that teeth size, although dependent on genetic contribution, are not insulated from external influences.

There is meagre scientific data pertaining to this among the Indian population. Furthermore, there is a scarcity of studies on deciduous population. Quantitative information on this would not only aid pediatric dentists, anthropologists and forensic odontologists, but would also cast a light on the odontometric trends of the population.

Hence the present study aims to establish a relation, if any, between Body Mass Index (BMI) and clinical crown length (CL), mesiodistal width (MDW) and buccolingual width(BLW) of primary maxillary canines and first molars, among Chennai children.

Materials and Methods

The study was undertaken following approval from the institutional ethical committee. This cross-sectional study was conducted among 100 school going children, of both genders, in the age group of 3-6 years, present in the outpatient ward of Department of Pedodontics, Saveetha Dental College and Hospitals, for a period of 3 months from October to December 2017. The children were included via random selection sampling, based on the inclusion criteria.

The inclusion criteria were: (1) caries free teeth with healthy gingiva and peridontium, (2) fully erupted deciduous teeth (53, 54, 63 and 64), (3) normal overjet and overbite, (4) normal molar and canine relationship. Participants with the following criteria were excluded: (1) mobile deciduous teeth, (2) incompletely erupted deciduous teeth, (3) presence of dental or facial anomalies, (4) apparent loss of tooth structure due to fractures, attritions and restorations, (5) any long standing systemic illnesses.

Following informed consent from parents of the children, demographic details were taken. All measurements were assessed by a single examiner to avoid inter-observer errors.

Calculation of Body Mass Index (BMI):

The weight of the individual was measured on a portable glass electronic weighing machine, in kilograms, measured to the nearest 0.1 kg. The height of individual was measured from vertex to floor, according to metric standards via a stature meter attached to the wall, to the nearest 0.1 cm. Body Mass Index was calculated by the metric formula: [Weight in Kg]/ [Height squared in meters]. The values were plotted on the age growth graph to obtain the percentile ranking of the child, which give the relative position of the child's BMI among other children of the same age and sex [13].

Based on the age and gender specific percentile curves given by Centers For Disease Control and Prevention, the children were classified into four groups: those with BMI below 5% of standard were considered underweight, between 5% and 85% as normal, Overweight between 85% and 95%, and those with above 95% as obese [14].

Clinical examination

The participants were measured for Crown length (CL), mesiodistal width (MDW) and buccolingual width (BLW) of primary maxillary canines and first molars using a digital Vernier caliper, to the nearest 0.01mm.

The parameters are explained as follows

CL: Greatest distance along the facial axis of tooth, from gingival margin to buccal cusp tip in case of canines, and from gingival margin to mesiobuccal cusp tip incase of molars.

MDW: Greatest distance between mesial and distal contact points of the crown, with the long axis of the caliper parallel to the occlusal surface.

BLW: Greatest distance between labial/buccal and lingual surface of the crown, measured with beaks of caliper perpendicular to MDW.

Statistical analysis

The anthropometric measurements and tooth dimensions were tabulated. Data was expressed in mean ± Standard deviation. The children of different BMI groups were compared on the basis of crown lengths, mesiodistal and buccolingual lengths, by ANOVA test. A two tailed p<0.05 was considered statistically significant. The data was compared and analyzed by SPSS software version 17.0.

Table 1: Demographic characteristics of study participants (n=100)

Variables	Subgroups
Gender	Male
	Female
BMI groups	Underweight
	Healthy
	Overweight

Fig. 1: Gender distribution among study participants

Table 2: Comparison of the mean±standard deviation of crown length of primary upper canine and molar among participants of BMI using one-way ANOVA test

Status	Primary canine	Primary molar
Healthy	4.9461±0.75	4.6392±0.66
Underweight	4.2909±0.57	4.4252±0.38
Overweight	5.2667±0.52	4.8661±0.49
p=0.00		

Results

Of total 100 participants, 52 were male and 48 were female. Considering the BMI of the participants, 49 were healthy weight, 33 were underweight, and the remaining 18 were of overweight status. Distribution of the children based on gender and BMI categories are represented (Table 1, Figure 1, 2). The data shows the comparison of the mean (SD) of CL, MDW, BLW of upper primary canine and first molar among participants of different body size using one-way ANOVA test (Table 2-4). There was a significant difference observed between the groups in relation to the CL, MDW and BLW ($p < 0.05$). This statistical comparison is represented in Figure 3, 4 and 5.

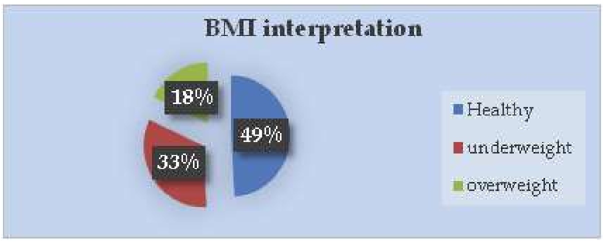

Fig. 2: Distribution of participants based on Body Mass Index criteria

Table 3: Comparison of the mean±standard deviation of mesiodistal width of primary upper canine and molar among participants of BMI using one-way ANOVA test

Status	Primary Canine	Primary Molar
Healthy	5.7129±0.57	5.9965±0.58
Underweight	4.877±0.46	5.3552±0.43
Overweight	5.2522±0.52	6.2717±0.488
p=0.00		

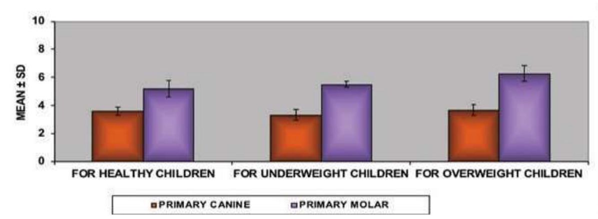

Fig. 3: Comparison of the crown lengths among participants of different BMI

Table 4: Comparison of the mean±standard deviation of buccolingual width of primary upper canine and molar among participants of BMI using one-way ANOVA test

Status	Primary Canine	Primary Molar
Healthy	3.6165±0.30	5.2216±0.58
Underweight	3.3367±0.39	5.5203±0.21
Overweight	3.6867±0.36	6.2822±0.54
p=0.00		

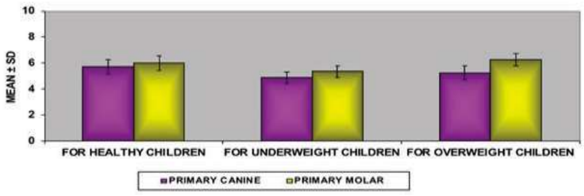

Fig. 4: Comparison of the mesiodistal widths among participants of BMI

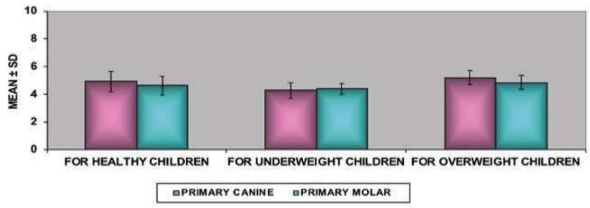

Fig. 5: Comparison of the buccolingual widths among participants of BMI

Discussion

It has been recognized for a long time that variations among tooth morphometrics exist across genders, age, populations and phenotypes. This study was initiated as a review of literature revealed a scarcity of evidence to support a variation of primary tooth metrics with body mass index. This study primarily focuses on presenting the utility of a correlation between primary tooth metrices and BMI. The results could have positive implications in pedodontic operative dentistry and orthodontics. Moreover, differences in variation could provide a means of studying evolutionary mechanisms across a particular population and may provide an insight into the nature of factors influencing this variation. The scientific data obtained would also be viable within a forensic context in development of a biological profile.

The current analysis shows a positive relation in variation of CL, MDW and BLWs among participants of different body sizes (Underweight, healthy and Overweight). Underweight individuals showed smaller CL, MDW and BLW compared to their overweight counterparts. The statistically significant variation in tooth measurements of the three BMI groups suggest that while genetic influences may play a role, there is significant stimulus from environmental influence, which may be socioeconomic conditions, nutrition, childhood health, maternal effects such as gestation and systemic conditions [8,9,15].

Previously conducted studies to establish a relation between tooth morphometrics and physical profile have shown differing results. Jayawardana CK et al. conducted a study on Srilankan Sinhalese individuals, attempting to find a relation between permanent Incisal tooth lengths and stature, and found no significant association [16]. Sterrett et al conducted a similar study on Caucasians, comparing width, length and width/ length ratios of permanent maxillary anteriors to stature, and came to a similar conclusion that tooth morphometrics do not have an association with body height [17]. However, a study by Prabhu et al comparing multiple dimensional parameters of permanent maxillary centrals to stature, had a low, albeit statistically significant result. Few studies have been carried out on deciduous dentition [18]. A study carried out by Ramanna et al showed a definite predictive relationship between deciduous clinical crown length and height of the individual [19]. The findings of our study contrasted that made by Zameer et al, who reported non-significant variations on comparing MDW of primary second molar among children with different BMI [8]. The conflicting results from the previous studies may be attributed to the choice of dentition, choice of parameters of tooth dimensions, different ethnicities and racial differences among the study groups.

Discrepancies in tooth size have been reported across various ethnic groups such as Mongoloids, Japanese, North American Caucasians and racial groups such as Eskimos, Bushmen and Australian Aboriginals. We chose our study population from Chennai, a metropolitan city having a mix of North Indians of Aryan origin, and South Indians of Dravidian Origin, as there is little information regarding normative data involving this population [5,6,7,20].

In this study, deciduous dentition was chosen over permanent dentition, as these dental structures carry on them the stamps of genetic traits as well reflect the effects of environmental influences [21]. The functional matrix theory, popularized by Melvin Moss in 1960, supports the above hypothesis, as it is firmly based on the fact that teeth, as functional matrices, are influenced by genetic, epigenetic and environmental factors, and that any disturbances in these, would in turn effect the related skeletal unit [22]. A domino effect triggered by this functional interference could result in an overall impact on other related skeletal structures, and hence, overall body size of the individual. Evidence has confirmed that while polygenic inheritances do influence deciduous tooth size variability, teeth fail to attain their maximum genetic size potential when there is an influence of stressors such as disease and malnutrition. Other external factors that may influence the size of developing deciduous dentition include maternal health, short prenatal growth periods, poor perinatal and early postnatal development [6,23]. This is clearly evidenced in a study by Garn et al, who, in collaboration with The National Collaborative Perinatal Project (NCPP), showed that maternal hypertension, low birth weight and short gestational periods resulted in diminished mesiodistal and buccolingual dimensions of all deciduous teeth, while conversely, conditions such as maternal diabetes, maternal hypothyroidism, and large size at birth resulted in larger maxillary and mandibular deciduous dentition, as compared to healthy neonates [6].

Children in the age group of 3 to 6 years were chosen as primary teeth begin to erupt around 2 ½ years and their replacement around the age of 6 [24]. Thus, it was imperative that children within this age group were chosen as the inclusion criteria.

The teeth selected for measurement were maxillary primary Canines and Molars. Previous studies have supported the use of maxillary teeth in a forensic context, the reason being, in cases of mass disasters where only fragmentary remains may be available, the maxilla offers the advantage of being firmly attached to base of skull and having standard anatomical landmarks by which they may be easily identified, for measurement of odontometric parameters [25]. In our study, maxillary teeth were chosen with the same intention. Canines and molars were selected due to their discrete morphologies which will add to the value of evidence.

The odontometric parameters chosen for this study were crown length (CL), mesiodistal (MDW) and buccolingual (BLW) widths. There appears to be a general consensus in literature that CL, MDW and BLW are the most commonly assessed, reliable parameters in tooth morphometrics due to the specificity and reproducibility of the variations obtained among them. An appreciable sexual variation among the parameters- MDW and BLW are larger in males compared to females- has long been established in literature and have been used as reliable forensic tools. Anthropologists have correlated mesiodistal widths and evolution of tooth size and drawn a parallel to this and populations and environmental adaptation. In our study, we have chosen to also include crown lengths and buccolingual widths as there is a dearth of information regarding these when it came to studies on primary tooth metrices [26].

The methodology used to measure the chosen parameters in the present study is based on work by Moorrees and Reed, who pioneered and standardized the location on the tooth where the measurement is to be made. As this method is the most commonly used in anthropological and dental literature, it facilitated easy comparison between results of the present study with those of others [27]. The measurements were made using a digital Vernier caliper, as they provide more reliable and accurate measurements, as compared to manual measurements done with dividers and calculators which result in measurement transfer and calculation errors [28]. The metrical data in our study was obtained directly from the patient's mouth. Majority authors used plaster models; however, there have been studies where direct intraoral measurements were taken from the mouth of the individual. Anderson's odontometric study comparing both direct and indirect techniques revealed no significant statistical difference comparing both methods [29].

Following these odontometric measurements, we proceeded to measure the anthropometric data. Body mass Index has been shown to have scientific and epidemiological consistency and has been used in numerous studies to effectively analyze anthropometric measurements. It's accuracy as a sensitive index, over other conventional indices have long been established. Studies have shown positive correlations between a high BMI and dental caries, blood pressure and periodontitis. BMI was our screening tool of choice for estimation of body size, owing to its effective categorization of individuals of different heights and weights based on age and gender [30,31,32].

The results of this study support the notion that while teeth may have substantial biological stability, it is evident that other definable factors operate on it, accounting for variance in crown size. The study provides normative data among individuals with different BMI in Chennai population and should be considered in population studies relating to tooth size and in understanding of different evolutionary trends. The similarities in odontometric values within a population may be explained by the impact of similar environmental prenatal influences on crown lengths and widths of developing teeth, or by the population's adoptive response to their diet. The normative data provided in this study for the pediatric Dravidian population of Chennai city, may plausibly allow for accurate prediction of ethnicity of the child, hence narrowing down the variables in a forensic situation. With multiple differences to work with, in terms of race, age, weight and gender, identification of the individual in a forensic situation may be a complex exercise. Attempts to even out these differences with more studies such as ours, will prove to be of indispensable value in studies of forensic odontology.

The quantitative information could be also be imperative when dealing with cases of tooth jaw size discrepancies, space management and in deciding deciduous crown size dimensions.

The limitations of the study lie in the small size of the chosen study sample and the random nature of sampling technique and hence, the findings may not replicate in a larger sample size. Thus, the authors recommend a larger cohort, chosen via systematically distributed sampling technique to provide substantial evidence to support these findings, which maybe then further generalized to an entire population.

Conclusion

A positive correlation exists a between body mass index and tooth metrics. Evident deciduous crown size variations of individuals of different BMI belonging to the same population should be taken into consideration while studying population comparisons of different odontometric standards, in forensic scenarios and clinical situations involving the fields of Orthodontics and Pediatric Operative dentistry.

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