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ODONTOMETRIJSKA KORELACIJA DUŽINE I VELIČINE ZUBA U PROCENI TELESNE VISINE: IZ PERSPEKTIVE FORENZIČKE NAUKE

ODONTOMETRIC CORRELATION OF TOOTH LENGTH AND SIZE FOR STATURE ESTIMATION: A FORENSIC PERSPECTIVE

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Sažetak

Uvod: *Dentalna morfometrija predstavlja primarnu metodu forenzičke identifikacije, posebno u slučajevima kada su skeletni ostaci nepotpuni ili kada nisu dostupni.*
Cilj: *Cilj ove studije bio je da ispita odnos između visine i različitih odontometrijskih parametara maksilarnog zubnog luka, uključujući interkaninu širinu (engl. Intercanine Width – IC), interpremolarnu širinu (engl. Interpremolar Width – IPW), kombinovanu meziodistalnu širinu (engl. Combined Mesiodistal Width –CW) anteriornih zuba, kao i individualne dužine zuba.*
Materijal i metode: *Ova studija preseka obuhvatila je šezdeset ispitanika (trideset muškaraca i trideset žena) starih od osamnaest do trideset godina, kojima su uzeti maksilarni zubni modeli. Odontometrijski podaci su dokumentovani pomoću digitalnog kalipera. Visina je merena standardnim stadiometrom. Pearsonova korelaciona analiza korišćena je za procenu povezanosti između visine i odontometrijskih karakteristika, dok je regresiona analiza primenjena za izradu prediktivne jednačine za procenu visine.*
Rezultati: *Pearsonova korelaciona analiza pokazala je značajnu pozitivnu korelaciju između interkanine širine i visine ($r = 0{,}489$; $p < 0{,}001$), dok je kombinacija ICW + IPW pokazala slabiju ali statistički značajnu povezanost ($r = 0{,}375$; $p = 0{,}003$). Ostali odontometrijski parametri nisu pokazali statistički značajnu korelaciju ($p > 0{,}05$). Kada je reč o individualnim dužinama zuba, samo je kod maksilarnog levog drugog premolara (zuba 25) zabeležena značajna negativna korelacija sa visinom ($r = −0{,}374$; $p = 0{,}038$). Regresiona analiza je identifikovala interkaninu širinu kao najbolji prediktor visine (visina = 129,234 + 2,165 × ICW; $R^2 = 0{,}25$; SEE = 6,7 cm).*
Zaključak: *Činjenica da su dimenzije zuba 25 i interkanina širina pokazale značajnu povezanost sa visinom zuba ukazuje na to da maksilarna odontometrijska merenja mogu služiti kao dodatno sredstvo prilikom forenzičke procene visine u slučajevima kada nema dugih kostiju.*

Ključne reči: *forenzička antropologija, forenzička odontologija, procena telesne visine, dužina zuba, odontometrijska analiza*

Abstract

Introduction: *Dental morphometrics is an important tool in forensic identification, especially when skeletal remains are incomplete or unavailable.*
Aim: *This study aimed to investigate the relationship between stature and various odontometric parameters of the maxillary arch, including intercanine width (IC), interpremolar width (IP), combined mesiodistal width (CW) of anterior teeth, and individual tooth lengths.*
Materials and Methods: *This cross-sectional study included 60 participants (30 males and 30 females) aged 18 to 30 years. Maxillary dental casts were acquired, and odontometric data were documented with a digital vernier caliper. Height was assessed utilizing a conventional stadiometer. Pearson's correlation analysis was employed to assess the link between height and odontometric characteristics, while regression analysis was conducted to construct a predictive equation for height estimation.*
Results: *Pearson's correlation analysis showed a significant positive correlation between intercanine width and stature ($r = 0.489$, $p < 0.000$), while IC + IP demonstrated a weaker but significant association ($r = 0.375$, $p = 0.003$). Other odontometric parameters showed no significant correlation ($p > 0.05$). Among individual tooth lengths, only the maxillary left second premolar (tooth 25) showed a significant negative correlation with stature ($r = −0.374$, $p = 0.038$). Regression analysis identified intercanine width as the strongest predictor of height (Height = 129.234 + 2.165 × IC; $R^2 = 0.25$; SEE = 6.7 cm).*
Conclusion: *The dimensions of tooth 25 and IC width exhibited a substantial correlation with stature, indicating that maxillary odontometric measurements may function as additional tools for forensic stature estimation in the absence of long bones.*

Key words: *forensic anthropology, forensic odontology, stature estimation, tooth length, odontometric analysis*

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Introduction

Dental morphometrics involves the quantitative evaluation of tooth dimensions and morphology, serving as a crucial tool in forensic odontology for individual identification[1]. By examining dental features, one can estimate a person's biological profile. In forensic human identification, two primary methodologies are typically utilized: comparative techniques and constructive procedures. Comparative approaches depend on the correlation of antemortem records, which include dental information from a living individual, such as dental charts, radiographs, and DNA profiles, with postmortem records that are detailed documents generated through the examination of a deceased person's teeth, focusing on the identification of key identifiers. Nevertheless, in numerous forensic scenarios, particularly when antemortem data is lacking or insufficient, these procedures become impractical. In these cases, constructive or reconstructive identification methods, which entail creating a biological profile through assessments of sex, age, ancestry, and stature, are essential[2,3]. Consequently, calculating height from odontometric characteristics is an essential component of biological profiling, offering a significant tool for human identification when direct comparison methods are unavailable[4].

One essential anthropometric characteristic that helps determine a person's physical identity is stature, or height[5]. Stature is considered one of the primary factors in forensic anthropology, alongside age, sex, and ancestry, and is essential for the preliminary evaluation and reconstructive identification of skeletal remains[6]. A basic anthropometric characteristic, stature indicates a person's height when standing up straight and has a clear proportionate relationship with several anatomical features, such as the foot, trunk, long bones, and cranial and facial bones[7]. Long bones are typically utilized to estimate stature in cases involving skeletal remains due to their strong correlation with height. In instances of decomposed, fractured, or damaged bodies, it is crucial to apply the proportional relationship between stature and various anatomical elements, including the head, face, trunk, and extremities, to aid in personal identification[8].

Teeth are highly resistant, especially under adverse circumstances such as high temperatures, and are often detected after the rest of the body has disintegrated[9]. Dental morphometrics can provide a reliable estimate of an individual's stature since teeth are one of the most chemically stable components of the human body. This is particularly relevant in forensic and archaeological contexts, as teeth are frequently recovered, even when other skeletal remains are absent[10]. Consequently, dental and oral characteristics are crucial for determining significant factors such as age, sex, and ancestry via odontometric analysis[11].

Extensive study has examined the use of permanent dental morphometrics to estimate physical stature, including measurements such as tooth length, crown length (CL), mesiodistal breadth, and labiolingual width, while seeking to correlate these metrics with face features[12,13]. Nonetheless, there has been a paucity of research on evaluating stature based on tooth structures like crown length, root length, and mesiodistal or buccolingual widths, which can be used to study how they relate to height. This study aimed to examine the relationship between height and odontometric features, encompassing intercanine width (IC), interpremolar width (IP) of the maxillary arch, as well as the mesiodistal crown width and tooth length of all permanent maxillary teeth up to the second molars, in addition to the combined mesiodistal width (CW) of all permanent maxillary anterior teeth, and the various combinations of IC + IP, IC + CW, IP + CW, and IC + IP + CW.

The emphasis on maxillary teeth arises from their enhanced preservation, accessibility, and measuring accuracy in forensic examination. The maxillary teeth, particularly the canines and premolars, exhibit distinct anatomical features that facilitate reliable odontometric evaluation on both physical specimens and radiographs[14]. They demonstrate greater resistance to postmortem deterioration, facilitate precise measurement by callipers and orthopantomograms, and reveal significant correlations with craniofacial proportions pertinent to stature estimation[15]. Therefore, focusing on the maxillary arch improves precision, consistency, and forensic relevance in stature assessment. The goal is to develop dependable methods for assessing stature using oral parameters. The findings of this study could significantly increase the efficacy of forensic and archaeological investigations by contributing to enhancement of identification possibilities when complete skeleton remains are not available.

The null hypothesis of the study includes no statistically significant relationship between height and odontometric features, including IC width, IP width, mesiodistal crown width, tooth length of permanent maxillary teeth up to the second molars, CW of permanent maxillary anterior teeth, or their combinations (IC + IP, IC + CW, IP + CW, IC + IP + CW).

Previous research examined the correlation between odontometric measurements and stature, revealing moderate associations between factors such as intercanine width, mesiodistal tooth size, and crown measurements and height across several populations. Nevertheless, the majority of research has concentrated on a small number of dental variables, and evidence assessing numerous maxillary odontometric features simultaneously remains limited.

The present study aimed to evaluate the correlation between height and several maxillary odontometric parameters, including intercanine width (IC), interpremolar width (IP), mesiodistal crown width, and tooth length of permanent maxillary teeth up to the second molars, as well as the combined mesiodistal width of maxillary anterior teeth and their combinations, to assess their efficacy in stature estimation.

Materials and Methods

This cross-sectional research included 60 participants recruited from the Institute's Outpatient Department. Informed consent was gathered from all participants following an explanation of the study's objectives and methodologies. Confidentiality and anonymity were ensured, and participation was voluntary, with the option to withdraw at any moment. All procedures followed the ethical standards of the Institutional Research Committee and the 1964 Helsinki Declaration and its later amendments or comparable ethical standards (approval number IECVDC/23/UG01/OP/IVT/90) of the Institutional Ethics Committee, Vishnu Dental College, India). The sample size of 60 was based on convenience sampling of participants who met the inclusion criteria during the study period. Because of the exploratory nature of the research and the limited availability of radiographic records meeting quality standards, the study was considered preliminary/pilot in design. The participants were drawn from a relatively homogenous population, patients of South Indian ancestry attending the Outpatient Department of Vishnu Dental College. Age and sex distribution were recorded but not stratified for analysis due to the limited sample size. Subjects who visited the dental hospital for regular dental checkups were selected for this study based on the following inclusion criteria: provided informed consent; fully erupted tooth; radiographs without any pathologies; radiographs with adequate density, contrast, and clarity; and the tooth with complete root formation. Exclusion criteria were as follows: blurred images and artifacts caused by metallic objects; missing teeth, attrited teeth, root-canal-treat teeth; periodontally compromised teeth, developmental anomalies, under orthodontic treatment; cleft palate; crowding and spacing; and any dental or surgical procedure that might change or obstruct a tooth's natural shape or accurate measurement of its size.

The individual mesiodistal crown width and tooth length of all permanent maxillary teeth till socond molars, maxillary IC width, maxillary IP width, CW of all permanent maxillary anteriors, IC + IP, IC + CW, IP + CW, IC + IP + CW, and stature (H) were measured and documented. A digital vernier calliper (Insize Digital Calliper, China) with an accuracy of 0.01 mm was utilized to measure the parameters. Following the completion of each patient's examination, the vernier calliper was sanitized using an antiseptic solution (surfacept). The sharp tines facilitated access to the interproximal portions of the teeth. The display was utilized to measure and document the distance between the tines.

The horizontal distance between the cusp points of the maxillary right canine and the cusp tip of the left canine was utilized to determine the IC width (Figure 1), while the IP width was derived from the horizontal distance between the buccal cusp tip of the maxillary first premolar from the right to the left side (Figure 2). The mesiodistal width of teeth 17 to 27 was measured at the anatomical contact locations using equipment aligned with the occlusal plane, directly on the subject. The CW of the maxillary anterior teeth was calculated by summing the individual mesiodistal widths of these teeth (Figure 3).

An orthopantomogram (OPG) was employed to ascertain tooth length. A Satelec X Mind Panoceph OPG machine equipped with photostimulable phosphor plates from Soredex was utilized to acquire panoramic radiographs for each participant. A single trained operator acquired all radiographs to reduce magnification and distortion errors, using uniform exposure settings. The system's magnification factor was calibrated according to manufacturer specifications, and measurements were taken with the same software to ensure consistency and accuracy.

The head posture was standardized using the machine's built-in cephalostat and laser alignment guides to ensure consistent orientation across all participants. The final images were processed using Scanora software and subsequently saved in DICOM format. Utilising OPG pictures, the lengths of individual maxillary teeth, excluding the third molars, were measured from the apex of the root to the tip of the buccal cusp for posterior teeth and to the tip of the incisal surface for anterior teeth (Figure 4).

Stature was calculated as the vertical distance from the apex of the head to the floor. The subject's posture should be standardized with the individual standing with an erect spine, heels together, and head in the Frankfurt plane. The height was measured in front of a scale calibrated to 0.1 cm on an immovable vertical plane. All measurements were conducted by a single examiner to eliminate interobserver error. Measurements were conducted with an accuracy of 0.01 mm for odontometric parameters and 0.1 cm for stature, employing millimetres (mm) and centimetres (cm), respectively.

Ten randomly selected radiographs and clinical measurements were reevaluated by the same examiner after a two-week interval. The Intraclass Correlation Coefficient (ICC) was calculated and showed high reliability (ICC = 0.91 for odontometric measurements and ICC = 0.93 for stature), indicating excellent reproducibility. All measurements in the present study were performed by a single experienced examiner to maintain procedural uniformity and minimize variability due to differing measurement techniques. To address this, the examiner was blinded to participants' stature during odontometric assessments, and each measurement was taken twice on separate occasions to enhance consistency.

Statistical Analysis

Data were analysed using IBM SPSS Statistics version 29.0 (New York, USA). Normality of data distribution was verified using the Shapiro–Wilk test, confirming that all variables followed a normal distribution ($p > 0.05$). Descriptive statistics (mean, standard deviation, minimum, maximum) were computed for age, sex, height, and odontometric parameters. Pearson's correlation coefficient (r) was used to evaluate relationships between stature and odontometric parameters. Multiple linear regression analysis was conducted to identify the most significant predictors of stature. The standard error of estimate (SEE) and coefficient of determination (R^2) were calculated to assess model accuracy and predictive precision. A scatter plot illustrating the correlation between predicted and actual stature values was generated to visually demonstrate model performance. A p-value ≤ 0.05 was considered statistically significant.

Figure 1. Measurement of inter canine width using a digital vernier caliper

Figure 2. Measurement of inter premolar width using a digital vernier caliper

Figure 3. Measurement of mesiodistal width of individual tooth

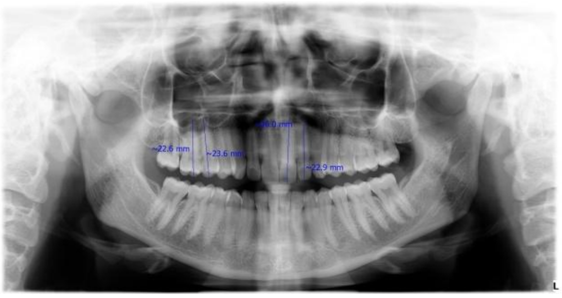

Figure 4. Measurement of tooth length on an orthopantomogram (OPG)

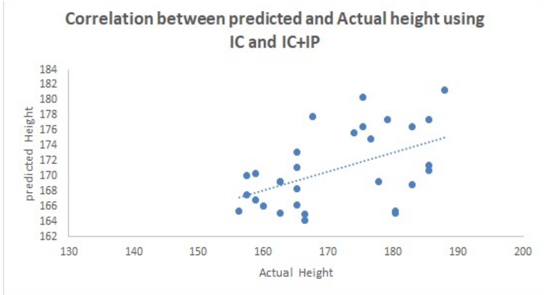

Figure 5. Correlation between predicted and actual height using IC and IC + IP

Results

A total of 60 participants were included in the study, comprising 30 males (50%) and 30 females (50%). The mean age of the participants was 22.8 ± 3.4 years, ranging from 18 to 30 years. The mean height of the participants was 160.0 ± 8.2 cm, ranging from 145 cm to 178 cm (Table 1). Pearson's correlation coefficient (r) was calculated to examine the relationship between stature and tooth width (seven odontometric characteristics) across all subjects, irrespective of sex distinctions. The Pearson correlation analysis revealed a statistically significant positive correlation between IC width and stature ($r = 0.489$, $p < 0.000$), suggesting a moderate and meaningful association. The combined parameter IC + IP demonstrated a statistically significant correlation with stature ($r = 0.375$, $p = 0.003$), but to a lesser extent. Other variables, such as IP width, CW, and their combinations (IC + CW, IP + CW, IC + IP + CW), showed no statistically significant correlations with stature ($p > 0.05$) (Table 2).

The multiple linear regression analysis examined the relationship between the independent variables IC and IC + IP with the dependent variable height. The model revealed that IC was a statistically significant predictor of Height ($B = 2.165$, $p = 0.005$), indicating that for every one mm increase in IC, Height increased by approximately 2.17 cm. The standardized Beta coefficient (0.683) further suggested that IC had a strong positive influence on Height. In contrast, the variable IC + IP showed no significant association with Height ($B = -0.437$, $p = 0.352$), suggesting that this predictor did not meaningfully contribute to explaining the variance in Height. Collinearity statistics revealed moderate multicollinearity between the two predictors (VIF = 4.246), which falls within acceptable limits but may still warrant further attention. Overall, IC emerged as the key predictor in this model, while IC + IP did not show a significant independent effect (Table 3).

Model 1: Stature prediction using IC and IC + IP

Height (cm) = 129.234 + 2.165 (IC) − 0.437(IC + IP)

$R^2 = 0.25$, SEE = 6.7 cm

IC was a statistically significant predictor ($B = 2.165$, $p = 0.005$), whereas IC + IP was not significant ($p = 0.352$). This indicates that each 1 mm increase in intercanine width corresponds to an approximate 2.17 cm increase in stature.

Model 2: Stature prediction using tooth 25 length

Height (cm) = 211.247 − 1.550 (tooth 25 length)

$R^2 = 0.140$, SEE = 7.2 cm. The negative regression coefficient indicates that greater tooth length was associated with slightly lower stature ($B = -1.550$, $p = 0.038$).

Pearson's correlation analysis of tooth length and height found that tooth 25 (maxillary left second premolar) had a statistically significant negative correlation with stature ($r = -0.374$, $p = 0.038$). This demonstrates a moderate inverse association, which means that when the length of tooth 25 increases, stature tends to decrease to a moderate extent. No other teeth showed statistically significant correlations (Table 4). The multiple linear regression analysis investigated the relationship between Height and tooth length, indicating that the length of 25 (maxillary left second premolar) served as a statistically significant predictor of Height. ($B = 211.247$, $p = 0.005$) (Table 5). Correlation between predicted and actual height using IC and IC + IP was done and represented (Figure 5). This displays a scatter plot illustrating the correlation between predicted height and actual height utilizing IC and IC + IP data. In this picture, each point denotes an individual participant, with actual height represented on the x-axis and predicted height on the y-axis. The dotted regression line illustrates the positive correlation between the variables, signifying that when actual height rises, the predicted height similarly tends to rise. The ascending trend in the scatter plot indicates the positive correlation observed in the statistical study.

Table 1. Mean values and standard deviations for the principal odontometric parameters

Parameter	**Mean ± SD**	**Minimum**	**Maximum**	**Units**
Height (H)	160.0 ± 8.2	145.0	178.0	cm
Intercanine width (IC)	32.5 ± 2.4	28.0	37.0	mm
Interpremolar width (IP)	38.9 ± 3.1	33.0	45.0	mm
Combined mesiodistal width (CW)	42.8 ± 2.9	38.0	48.0	mm
Tooth 25 length	21.5 ± 1.9	18.0	25.0	mm

Table 2. Correlation between Height and tooth width using Pearson's correlation

Variables	**r value**	**P-value**
Stature	0.130	0.321
IP	0.130	0.130
IC	0.489	0.000**
CW	−0.101	0.442
IC + IP	0.375	0.003*
IC + CW	0.188	0.151
IP + CW	−0.133	0.312
IC + IP + CW	0.205	0.116

Table 3. Multiple linear regression analysis between Height and tooth width

R^2 = 0.251								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	129.234	17.995		7.182	0.000		
	IC	2.165	0.749	0.683	2.890	0.005	0.236	4.246
	IC + IP	−0.437	0.466	−0.222	−0.938	0.352	0.236	4.246
a. Dependent Variable: Height								

Table 4. Correlation between Height and tooth length using Pearson's Correlation

Variables	HEIGHT	
	r value	p-value
11	−0.108	0.562
12	−0.235	0.203
13	−0.243	0.188
14	−0.212	0.251
15	−0.262	0.154
16	−0.192	0.302
17	−0.288	0.117
21	−0.102	0.585
22	−0.194	0.295
23	−0.193	0.299
24	−0.204	0.271
25	−0.374*	0.038*
26	−0.034	0.856
27	−0.274	0.137

Table 5. Multiple linear regression analysis between Height and tooth length

R^2 = 0.140						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	211.247	18.449		11.450	0.000
	25	−1.550	0.713	−0.374	−2.174	0.038
a. Dependent Variable: Height						

Discussion

Forensic odontology is a crucial field within forensic science that utilizes dental knowledge for legal enquiries, especially in the identification of human remains. Teeth, owing to their remarkable resilience, frequently endure conditions that obliterate other tissues, rendering them essential for constructing biological profiles when remains are fragmented16. Although long bones are generally employed for stature estimation, teeth provide a significant alternative when such bones are inaccessible. Their morphometric characteristics namely length, width, and arch dimensions, exhibit significant associations with height[17]. This study demonstrates that IC width and the length of tooth 25 (maxillary left second premolar) are statistically significant predictors of height, emphasizing the value of dental morphometrics, specifically arch width and individual tooth length as dependable adjuncts for forensic stature estimation, particularly in situations of fragmented or incomplete remains.

The present study findings indicate that the null hypothesis was rejected only for inter canine width and partially for the length of tooth 25. A moderate and statistically significant correlation between inter canine width and stature was found, however no such correlation was observed for the combined metric IC + IP (Table 3). This might be because there is a lack of homogeneity in the IP measurements taken from the same population due to individual differences in arch shape or alignment, which has a greater impact on premolar placement than canines. While intercanine width is biologically linked to craniofacial growth and overall body size, the relationship identified with the second premolar lacks a clear anatomical reason and may be due to random variation in this small pilot sample. It is possible that the individual predictive power of composite measures is reduced due to the overlapping variance shown by the moderate multicollinearity between IC and IP.

Our results correspond with the study conducted by Yadav et al., which also recognized canine width as a crucial predictor of stature[18]. Our findings align with the research from Jani et al., which demonstrated a significant correlation between height and IC (r = 0.223, p = 0.025), although IP and combined odontometric measurements (IC + IP, IC + CW, etc.) showed no significant correlation. Their regression model, founded on IC, exhibited reliability when utilized on a test dataset[19]. Collectively, our findings highlight the significance of intercanine width as a reliable odontometric indicator for stature assessment, especially in forensic scenarios where other skeletal components are absent.

Revathy et al. conducted a study that revealed a feeble statistically significant association between height and the total mesiodistal width of maxillary anterior teeth (r = 0.091 for females and 0.093 overall), with no significant correlation observed in males. Their regression models had restricted predictive power (R^2 = 0.04–0.057), underscoring the hypothesis that odontometric traits, such as IC, could serve as significant supplementary indicators for stature assessment, particularly when long bones are unavailable[20].

Hossain et al. investigated the correlation between the size of a person's tooth crown and their height in a group of people from Southeast Asia. Crown length, mesiodistal breadth of central incisors and canines, and individuals' height were found to be statistically significantly yet moderately correlated (r = 0.35−0.45). Combining measurements, especially the sum of crown length and mesiodistal breadth of central incisors and canines, yielded the best correlation (r = 0.537). Nevertheless, even with these statistical correlations, the regression models revealed a large discrepancy between the real and estimated heights, with inaccuracies reaching a maximum of 16.5 cm[21].

Our study identified the length of tooth 25 as a statistically significant predictor of stature (B = 211.247, p = 0.000) (Table 4), highlighting the possible application of individual tooth lengths in height estimation. This corresponds with the results of Narayanan et al., who identified a notable association between height and various tooth lengths, with correlation coefficients (r) between 0.12 and 0.57. Their research found maxillary molars, premolars, and canines, specifically the right second molar and first premolar, exhibited the most significant correlations with stature. Although their investigation incorporated numerous teeth in regression modelling, our findings underscore that even a single tooth, such as the upper second premolar, can function as a dependable metric for stature assessment, particularly in instances with scant dental remains[22]. These findings enhance the increasing evidence favoring the utilization of tooth length in forensic stature assessment in the absence of skeletal remains.

Our study findings contradict those of Rao et al., who investigated four odontometric parameters: IC width, IP width, arc length, and CW of anterior teeth across three Asian ethnicities (Malay, Indian, Chinese). Notably, the analysis revealed that only arc length had a significant link with stature (r = 0.287, p = 0.002), while IC and IP demonstrated no significant correlation. Their regression model utilizing arc length produced a weak R^2 of 0.08, indicating restricted explanatory capacity[23]. The absence of significance for IC in their study, in contrast to the moderate correlation identified in ours, may be ascribed to ethnic diversity or disparities in sample selection.

The regression models in this study exhibited limited explanatory and predictive power, with R^2 values of 0.25 for Model 1 and 0.14 for Model 2. The values suggest that a limited proportion of the variance in the outcome was explained, indicating that the predictive accuracy of the models requires cautious interpretation. The inclusion of both IC and IC + IP in the same regression model results in multicollinearity, given that IC is contained within the IC + IP composite variable. The observed VIF of approximately 4.2 indicates moderate collinearity, which should be recognized. Multicollinearity can increase standard errors, diminish statistical precision, and lead to unstable regression coefficients.

The observed negative association between the length of tooth 25 and stature is biologically unexpected and may reflect random variation rather than a true anatomical relationship, especially given the limited sample size and modest effect size.

This finding must be interpreted with caution and confirmed in bigger, population-based studies.

Our findings also differ from those of Panigrahi and Babu, who specifically assessed the second maxillary inter premolar distance and its association with height. Their findings demonstrated minimal correlation coefficients ($r = 0.05$ for males and $r = 0.13$ for females), suggesting that interpremolar distance is not a reliable predictor for stature estimation[24]. In contrast to our findings, which emphasize the forensic significance of IC, their data reveal the heterogeneity in predictive capacity across several dental characteristics. This emphasizes the necessity for population-specific and parameter-specific validation in the application of dental measurements for forensic stature assessment. Previous studies done by Rao et al.[23], Panigrahi and Babu[24] have reported weaker or differing results, which are mainly attributed to population variation; other factors, such as limited sample size, methodological differences, and measurement inconsistencies, may also account for these discrepancies. Identifying these alternative influences facilitates a more proportionate interpretation of variations among studies.

Although the sample size in this pilot study was limited for sex-stratified evaluation, it is crucial to note that sex has a considerable influence on both stature and odontometric dimensions. By combining male and female individuals, the study may have missed any sex-specific trends, which should be noted when interpreting the results. Future research with bigger sample sizes should include sex-based stratification or adjustment to increase analytical accuracy.

The enormous demographic diversity of India leads to variations in stature based on geographical location, caste, and tribe. Given that stature is affected by genetic, environmental, and climatic variables, it is imperative to utilize population-specific regression models to enhance precision in forensic identification. Our results endorse the utilisation of IC width and individual tooth length (25) as potentially useful predictors for estimating age that requires validation in larger samples.

Limitations

This study's primary limitation is its relatively small sample size and focus on a single population group, potentially restricting the generalizability of the regression models. The use of OPGs presents potential magnification and distortion errors, even with standardization and calibration efforts in place. The presence of moderate collinearity between IC width and IP width complicates regression analysis and may affect the accuracy of predictive models. Future multicentric studies with larger and more diverse populations are necessary to validate these preliminary findings and enhance the generalizability of odontometric parameters for stature estimation across various demographic groups.

Conclusion

This research established that IC width and the length of tooth 25 are statistically significant odontometric indicators that exhibit moderate correlations with stature. These parameters may function as useful adjuncts in forensic stature estimation, especially in cases where skeletal remains are incomplete or absent. Given the limited sample size and moderate strength of associations, these findings warrant cautious interpretation and should be considered preliminary. Subsequent studies must confirm these findings in larger and more heterogeneous populations, utilizing standardized reliability evaluations and methodological improvements to reduce radiographic distortion and improve measurement accuracy. Creating strong, population-specific regression models will enhance the forensic utility of odontometric parameters in human identification.

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