

Employing Dimensional Disparity of Teeth to Establish the Gender in Odisha Population: A Dimorphic Study

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ABSTRACT

Aims and Objectives: Determination of sex is one of the most important and crucial steps in forensic science. Sexual dimorphism using odontometric analysis is found to vary in different populations making it necessary to attain values of a specific population which helps the identification possible. This present study attempts to establish sexual dimorphism using odontometric analysis in Odisha population.

Materials and Methods: A total of 200 subjects (100 male and 100 female) between ages 18 and 25 years were included in the study. Intraoral Mesiodistal (MD) and Buccolingual (BL) dimensions of 28 teeth (maxillary and mandibular) excluding third molar were taken using digital Vernier calipers. Data were charted and decrypted and statistical analysis was done using SPSS Software version 20.

Results: Our study showed larger dimensions of tooth in males when compared to females (maxillary right and left central incisor, 1st and 2nd molar). Interestingly, reverse dimorphism was also observed in few teeth.

Conclusion: The results of the present study showed that the linear (MD and BL) dimensions of teeth played a major role in the determination of gender in individuals. The variations or reverse dimorphism could be a result of geographic variations.

KEYWORDS: Linear dimensions, maxillary and mandibular teeth, odontometric analysis, sexual dimorphism

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INTRODUCTION

“Forensic anthropology” is a branch of physical anthropology that helps in the identification of human remains for any medicolegal reasons.^[1] The forensic anthropologist works on the skeletal and dental remains, hair samples, blood, fingerprints, footprints, etc., in estimation/determination of the four main features of biological identities (gender, age, stature, and race) of individuals whose death is natural or unexplained.^[2,3]

The first step in the process of forensic human identification is gender determination as it cuts the number of possible matches to half.^[4] Even gender determination is done before age and stature estimation.^[2] Skeletal remains such as skull, pelvis, femur, humerus, radius, clavicle, and ulnae are found to be useful in sex

dimorphism.^[4,5] Odontogenesis is a complex process where about 300 genes are involved which determine the size, shape, and structure of the tooth.^[6] Tooth is the hardest structure of the human body that has more resistance to taphonomic degradation than osseous tissue.^[4] Tooth size and morphology are characteristic for males and females which has been considered to be a reliable source in gender determination which has been used widely by forensic experts.^[7] Studies done in the past have shown that crowns of the tooth are

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comparatively larger in males than females because of prolonged amelogenesis in males.^[8]

Forensic experts, anthropologists, and odontologists use linear (buccolingual [BL] and mesiodistal [MD]) diagonal dimensions and dental indices of tooth in the determination of sex.^[9-11] Very few studies have included all the permanent teeth for odontometric investigations.^[12,13] The present study, therefore, has been conducted to investigate the differences in the linear and diagonal dimensions of teeth in males and females of Odisha population.

MATERIALS AND METHODS

A cross-sectional study was conducted in the Department of Oral Pathology and Microbiology, Kalinga Institute of Dental Sciences, Bhubaneswar, from April 2017 to December 2017. A total of 200 subjects, 100 male and 100 female, were selected according to the *t*-test applied for the study, G power was used to calculate the sample size, which came to 52. Considering this, we increased the sample to minimize the error. All the participants, students of Kalinga Institute of Dental Sciences Native of Odisha, whose age ranged between 18 and 25 years, were included in the study as the tooth wear is minimal in this age group, thereby maximizing the odontometric information of Odisha population. All the participants were informed about the study, and a prior consent was obtained from all the study participants. Ethical clearance was obtained from the Institutional Ethical Committee (KIDS/RES/05/17).

The inclusion criteria were individuals with all completely erupted permanent maxillary and mandibular teeth except third molars, individuals native of Odisha, individuals with healthy caries-free teeth, individuals without any developmental anomalies affecting the size and shape of teeth, and individuals without any malocclusion. The exclusion criteria were individuals with caries teeth, individuals with restored teeth, individuals with any prosthesis, and cleft palate patients.

The aim of the study was to measure the MD and BL dimensions of all the permanent maxillary and mandibular teeth except third molars and to evaluate the existence of sexual dimorphism using these measurements in Odisha population.

The subjects were made to sit on the dental chair and measurements were recorded intraorally using a digital vernier caliper with resolution of 0.01 mm by a single observer. Only MD and BL dimensions of all the permanent maxillary and mandibular right- and left-sided teeth except for the third molars were recorded. Mesiodistal Dimension (MD) – it is the greatest distance

between the mesial and the distal surface of the crown Buccolingual Dimension (BL) – it is the greatest distance between the buccal and the lingual surface of the crown parallel to the long axis of the tooth.

Before commencement of the study, to assess the degree of error, 15 subjects who fulfilled the inclusion criteria were randomly selected and their MD and BL measurements of all the teeth except third molars were taken. After 1 week, the measurements were recorded again. Intraobserver error was calculated using paired *t*-test and the errors were very minimal which are unlikely to bias the results.

All the measurements were tabulated in Microsoft Excel and statistical analysis using *t*-test was done to compare the dimensions. Gender dimorphism was calculated for both MD and BL dimensions using the formulae given by Deo.^[3]

$$\text{Gender Dimorphism} = ([\text{MMTD}/\text{MFTD}] - 1) \times 100$$

Where MMTD is mean male tooth dimension and MFTD is mean female tooth dimension.

RESULTS

Descriptive statistics of MD [Tables 1 and 2] and BL dimensions [Tables 3 and 4] of all the permanent maxillary and mandibular teeth except third molars are given. The mean MD diameter of the right and left maxillary central and lateral incisors were 8.21 mm, 6.45 mm, 7.99 mm, and 6.35 mm in males and 7.44 mm, 6.21 mm, 7.34 mm, and 6.11 mm in females which was statistically significant. Maxillary right and left canines' MD dimensions were 7.21 mm and 7.06 mm in males and 7.22 mm and 7.10 mm in

Table 1: Describes the mean, standard deviation, and *P* value of mesiodistal dimensions of maxillary teeth (Student's *t*-test)

Tooth number	Male		Female		<i>t</i>	<i>P</i> *
	Mean	SD	Mean	SD		
11	8.21	0.61	7.44	0.32	7.9244	0.0001*
12	6.45	0.50	6.21	0.44	2.5979	0.0108*
13	7.54	0.81	7.04	0.75	-0.0727	0.0010*
14	6.60	0.67	6.45	0.57	1.2145	0.2275
15	6.45	0.69	6.24	0.39	1.8271	0.0707
16	10.52	1.16	9.68	0.44	4.7846	0.0001*
17	9.33	0.88	8.50	0.53	5.6376	0.0001*
21	7.99	0.70	7.34	0.34	5.8845	0.0001*
22	6.35	0.36	6.11	0.36	3.4377	0.0009*
23	7.10	0.58	7.06	0.90	-0.2680	0.7892
24	6.44	0.66	6.44	0.50	-0.0068	0.9946
25	6.35	0.58	6.17	0.46	1.6502	0.1021
26	10.38	1.06	9.47	0.49	5.5042	0.0001*
27	9.24	0.92	8.43	0.59	5.2064	0.0001*

**P*<0.05%; SD=Standard deviation

Table 2: Describes the mean, standard deviation, and P value of mesiodistal dimensions of mandibular teeth

Tooth number	Male		Female		t	P*
	Mean	SD	Mean	SD		
31	5.18	0.53	5.34	0.28	-1.8746	0.0638
32	5.52	0.39	5.44	0.20	1.1822	0.2400
33	5.63	0.46	5.64	0.41	-0.0593	0.9529
34	6.74	0.58	6.62	0.27	1.3181	0.1905
35	7.03	0.58	6.71	0.23	3.6936	0.0004*
36	10.39	0.67	10.29	0.36	0.9632	0.3378
37	9.97	0.83	9.87	0.19	0.8564	0.3939
41	5.08	0.57	5.23	0.33	-1.5597	0.1221
42	5.32	0.67	5.44	0.30	-1.1626	0.2478
43	5.54	0.56	5.51	0.37	0.2484	0.8044
44	6.60	0.88	6.53	0.31	0.5384	0.5915
45	6.73	0.87	6.65	0.35	0.5980	0.5512
46	10.19	0.85	10.19	0.47	0.0393	0.9687
47	9.78	0.95	9.73	0.36	0.3907	0.6969

*P<0.05%; SD=Standard deviation

Table 3: Describes the mean, standard deviation, and P value of buccolingual dimensions of maxillary teeth

Tooth number	Male		Female		t	P*
	Mean	SD	Mean	SD		
11	6.60	0.56	6.32	0.55	2.5294	0.0130*
12	5.53	0.72	5.40	0.47	1.1011	0.2736
13	7.05	1.03	6.89	0.55	0.9746	0.3322
14	8.18	1.20	7.81	0.63	1.9175	0.0581
15	8.40	1.17	7.76	0.79	3.1875	0.0019*
16	11.25	1.09	10.45	0.40	4.8524	0.0001*
17	10.30	0.76	9.50	1.19	3.9938	0.0001*
21	6.48	0.59	6.09	0.65	3.1188	0.0024*
22	5.48	0.62	5.65	0.54	-1.5023	0.1362
23	7.00	1.08	6.76	0.63	1.3635	0.1758
24	8.14	0.92	7.59	0.59	3.5082	0.0007*
25	8.44	0.88	7.75	0.77	4.1554	0.0001*
26	11.12	1.05	10.29	0.44	5.1900	0.0001*
27	10.02	1.08	9.39	1.16	2.8401	0.0055*

*P<0.05%; SD=Standard deviation

females, respectively, which were statistically insignificant. The mean MD dimensions of the right and left first and second premolars showed 6.60 mm, 6.45 mm, 6.44 mm, and 6.35 mm in males and 6.45 mm, 6.24 mm, 6.44 mm, and 6.17 mm in females. In case of left first and second molars, males showed 10.38 mm and 9.24 mm mean MD dimensions where females showed 9.47 mm and 8.43 mm, whereas on the right side of the quadrant, it was 10.52 mm and 9.33 mm in males and 9.68 mm and 8.50 mm in females. Males had statistically significant greater MD dimension compared to females in all the maxillary teeth except the canines [Table 1].

The mean BL dimensions of maxillary right and left anterior teeth were 6.60 mm, 5.53 mm, 7.05 mm,

6.48 mm, 5.48 mm, and 7.00 mm in males and 6.32 mm, 5.40 mm, 6.89 mm, 6.09 mm, 5.65 mm, and 6.76 mm in females, respectively. The right lateral incisor showed no statistical significance between males and females. The premolars of both right and left quadrants showed 8.18 mm, 8.40 mm, 8.14 mm, and 8.44 mm in males and 7.81 mm, 7.76 mm, 7.59 mm, and 7.75 mm in females, of which only the right first premolar did not show statistical significance between males and females. Both right and left first and second molars showed statistical significance between males and females in their BL dimensions which were 11.25 mm, 10.30 mm, 11.12 mm, and 10.02 mm in males and 10.45 mm, 9.50 mm, 10.29 mm, and 9.39 mm in females, respectively [Table 3].

The mean MD dimension of all the permanent mandibular left teeth in males was 5.18 mm, 5.52 mm, 5.63 mm, 6.74 mm, 7.03 mm, 10.39 mm, and 9.97 mm, respectively, and 5.34 mm, 5.44 mm, 5.64 mm, 6.62 mm, 6.71 mm, 10.29 mm, and 9.87 mm in females, respectively, of which only the left second premolar (35) showed a significant difference between males and females. The mandibular right MD dimensions of all the teeth in males were 5.08 mm, 5.32 mm, 5.54 mm, 6.60 mm, 6.73 mm, 10.19 mm, and 9.78 mm, respectively, whereas in females, it was 5.23 mm, 5.44 mm, 5.51 mm, 6.53 mm, 6.65 mm, 10.19 mm, and 9.73 mm, respectively, which showed no relevant statistical significance [Table 2].

On comparing the mean BL dimensions of mandibular teeth in males and females, statistical significance was seen in mandibular left central incisor (5.40 mm in male and 5.70 in female), left first premolar (7.22 mm in male and 7.45 mm in female), right canine (6.37 mm in male and 6.00 mm in female), and right first premolar (6.88 mm in male and 7.23 mm in females) [Table 4].

DISCUSSION

The earliest authenticated human remains in South Asia date to about 30,000 years ago. India is a country with cultural diversity. Odisha, one among those states in India which bears populations with different ethnic origin, has been traditionally vulnerable to the natural disasters on the account of its unique geo-climatic conditions.^[14]

Identification of dead using skeletal and dental remains is one of the most challenging aspects of forensic medicine. Sex determination is critical and most important criteria in defining the identity of an individual. Sex dimorphism using teeth and their measurements is one of the most reliable methods in comparison with other anatomic structures studied as they are least affected and survive major disasters. Analysis of deoxyribonucleic acid, bone

Table 4: Describes the mean, standard deviation, and P value of buccolingual dimensions of mandibular teeth

Tooth number	Male		Female		t	P*
	Mean	SD	Mean	SD		
31	5.40	1.01	5.70	0.19	-2.0142	0.0467*
32	5.87	0.97	5.86	0.25	0.1061	0.9157
33	6.14	0.91	6.10	0.43	0.2270	0.8209
34	7.22	0.71	7.45	0.27	-2.2121	0.0293*
35	7.83	0.65	7.97	0.44	-1.2454	0.2159
36	10.03	0.82	9.98	0.52	0.4128	0.6807
37	9.72	0.86	9.58	0.37	1.0040	0.3178
41	5.52	0.78	5.69	0.27	-1.4929	0.1387
42	5.86	0.84	5.72	0.30	1.1602	0.2488
43	6.37	0.58	6.00	0.47	3.5420	0.0006*
44	6.88	0.97	7.23	0.35	-2.3621	0.0201*
45	7.70	1.04	7.75	0.54	-0.2696	0.7881
46	9.77	0.77	9.75	0.70	0.1296	0.8972
47	9.34	1.04	9.41	0.47	-0.4555	0.6498

*P<0.05%; SD=Standard deviation

ossification tests, and measurements of teeth have been used as the most popular investigative methods.^[15]

The development of teeth happens before the maturation of skeletal apparatus making them one of the most valuable adjuncts in sex dimorphism. Studies done by Agnihotri *et al.*^[15] and Deo,^[3] Acharya and Mainali,^[9] and many authors have shown that teeth can be used as a reliable tool in sex indication.

The odontometric variables play an important role in sex estimation which includes biochemical, nonmetric, and metric analysis. Our study was based on a dental metric method which is based on the linear measurements of teeth (BL/MD dimensions). Capitaneanu *et al.*^[16] in his systematic review showed that there were about 34 studies which were done based on odontometric measurements. These studies highlight the importance and differences in the data occurring due to geographic, environmental, and genetic factors. Hence, our study was aimed to determine the odontometric sex assessment in Odisha population as differences exist in these features within the same population with a similar evolutionary context since there are no data till date revealing the sex dimorphism of this population.

Many studies were conducted to determine the sex dimorphism taking a single tooth^[3,17] or few teeth^[18-21] or a quadrant^[22] into consideration. Some studies have chosen either MD or BL dimensions in sex determination. In our study, we have included both the MD and BL dimensions and all the permanent teeth except third molars which is similar to studies done by Srinivasprasad *et al.*^[23] and Babu *et al.*^[24] in Indian population.

A significant difference was observed in BL dimensions between males and females when compared to MD

dimension which was in consistent with the studies done by Acharya and Mainali,^[9] Macaluso,^[4] Srinivasprasad *et al.*,^[23] and Narang *et al.*^[25] This could be attributed to the greater visibility and accessibility in recording the buccolingual dimensions as compared to mesiodistal diameter. Ghose and Baghdady and Harris and Nweeia^[26,27] considered BL diameter of the crown to be more reliable due to the difficulty encountered in measuring the mesiodistal diameter because of the proximal contact that exists between the teeth. In our study, maxillary first molar both right and left sides and maxillary right second molar showed significant value for both the BL and MD dimensions which is similar to the study conducted by Deo^[3] and Babu *et al.*^[24] in contrast with the study done by Lakhanpal *et al.*^[22] where only MD dimension showed a significant difference, this may be due to less sample size (50 M and 50 F) in their study.

BL diameter of all the maxillary teeth except the left and right lateral incisor showed greater dimensions in males as compared to females. Statistical significance was observed in maxillary right and left central incisor, right second premolar, left first and second premolars, and left first and second molars which is in contrast to studies done by Babu *et al.*^[24] and Srinivasprasad *et al.*^[23]

In our study, the MD dimension of the maxillary teeth did not show statistical significance only in the right and left canines and premolars (both first and second), whereas the significance was not observed in the right and left second molars' right central incisor and right canine in a study done by Babu *et al.*,^[24] whereas right lateral incisor and right and left first molar did not show significance in a study done by Srinivasprasad *et al.*^[23] On observing the MD dimensions of mandibular teeth, the left central incisor, left canine, right central incisor, and right lateral incisor showed greater dimensions in females than males which is similar study done by Babu *et al.*^[24] in South Kerala.

Our study exhibited reverse dimorphism in maxillary left and right lateral incisors canines, mandibular right and left central incisor, right lateral incisor, and left canine similar to studies done by Babu *et al.*,^[24] Ghose and Baghdady,^[26] and Harris and Nweeia,^[27] whereas it was left lateral incisor in a study done by Srinivasprasad *et al.*^[23] Previous studies have suggested that the reason for this reverse dimorphism could be evolution which is resulting in overlap of these linear dimensions in males and females. Some authors have attributed that this is due to environmental, cultural, and genetic factors.^[22]

Linear dimensions of the tooth act as an excellent parameter which is a simple, affordable, and reliable method for sex determination from the dental remains. Using both MD and BL dimensions, the sex dimorphism

becomes far better and accurate. Further studies can be done to procure extended data which can be used by forensic experts as adjuncts to establish sex dimorphism in mass disasters.

CONCLUSION

Our study exhibits dimorphism and reverses dimorphism based on the odontometric analysis. Evidences suggest that the magnitude of sexual dimorphism is neither specific to region nor it is genetically independent. Observed variations in the dimorphic character could be the result of genetic, cultural, or environmental factors. Literature review showed no studies pertaining to odontometric analysis in Odisha population. Further studies should be done with larger sample size to evaluate the accuracy of these parameters in gender determination.

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CONFLICTS OF INTEREST

There are no conflicts of interest.

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