International Journal of Oral Health Dentistry 2023;9(1):5–9

Content available at: https://www.ipinnovative.com/open-access-journals

International Journal of Oral Health Dentistry

Journal homepage: www.ijohd.org

Original Research Article

Identification of dental sexual dimorphism in deciduous teeth using craniometry and odontometry: A cross sectional study

Safina Masroor[1,*], Nagaveni N.B[2], Poornima P[2]

[1]*Sri Rajiv Gandhi College of Dental Sciences, Bengaluru, Karnataka, India*
[2]*College of Dental Sciences, Davangere, Karnataka, India*

A R T I C L E I N F O

Article history:
Received 20-12-2022
Accepted 14-01-2023
Available online 15-04-2023

Keywords:
Forensic anthropometry
Sexual dimorphism
Tooth crown area
Cephalic index

A B S T R A C T

Background: Sex determination is an important aspect in identification of individuals especially in cases of identifying victims of mass disasters, organised crimes etc. Odontometry is the measurement and study of tooth size. Cranial anthropometry is the measurement of skull dimensions and is considered to be a versatile technique in the investigation of the craniofacial skeleton because of its validity and practicality.
Aim: To assess tooth crown area of the deciduous molar teeth, to assess head size, to evaluate the extent of sexual dimorphism using head and dental dimension
Methodology: This study was done in 150 boys and 150 girls. Maxillary and mandibular arch impressions were made, casts were made with dental stone. A vernier calliper was used for obtaining the measurements. Mesiodistal width and buccolingual width of all the molars were measured in millimetres, tooth crown area (TCA) was calculated. Head dimensions were measured using Martin spreading calliper, Cephalic Index (CI) was calculated. Statistical analysis was done using unpaired "t" test, and logistic regression analysis was performed.
Results: The highest tooth crown area was shown by mandibular left second deciduous molar for both boys and girls ($p<0.05$). Boys showed higher cephalic index compared to girls ($p<0.05$). The highest percent dimorphism was obtained for maxillary left first deciduous molar.
Conclusion: Tooth crown area and head size can serve as a valuable aid for sex determination in pediatric population.

1. Introduction

Across all continents, every human being belongs to the same species. Every individual, including monozygotic twins, differs from the other in their measurable traits.[1] Various aspects of teeth such as shape and size, also come under such measurable traits. For this reason dental evidence has been often gathered for identification of victims of mass disasters, organised crimes and abuse.[2] In such cases, sex determination also is of paramount importance in cases especially when visual identification of the sex is impossible, thus eliminating about 50% of possibilities in the examined population.[3]

Odontometry is the measurement and study of tooth size. It has been used to study human phenotypic variation in biological anthropology and bioarchaeology.[4] Based on the differences in tooth dimensions in males and females, sex determination can be done using these dental features along with comparison of frequencies of nonmetric dental traits.[5]

The measurement of skull dimensions is known as Skull anthropometry or cranial anthropometry. Due to its validity and practicality, it has been considered to be a versatile technique in the investigation of the craniofacial skeleton,

* *Corresponding author*.
E-mail address: drsafinamasroor@gmail.com (S. Masroor).

https://doi.org/10.18231/j.ijohd.2023.002

with the skull and pelvis being the most reliable part of the skeleton. The size, robustness and metric characteristics aid in distinguishing male and female skulls. Among the craniometric measurements cephalic index is expressed using head length and head width to derive cranial size.[6]

Both the cranial and dental parameters, demonstrate significant sexual differences, and have been used for gender determination. Based on this premise, the present study was carried out to demonstrate the extent of sexual dimorphism of tooth and cranial size in pediatric population in Davangere and their potential in gender assessment.

Hence, this study was conducted with the aim of assessing the tooth crown area of the teeth and to assess head size; to evaluate the extent of sexual dimorphism.

2. Materials and Methods

A sample size of 300 children (equally divided boys and girls was included aged between 3-6 years) fulfilling the inclusion criteria were randomly selected from the Department of Pediatric and Preventive Dentistry at College Of Dental Sciences, Davangere, Karnataka, India.

2.1. Inclusion criteria

Absence of any gingival or periodontal diseases, absence of dental caries and fully erupted deciduous molar teeth.

2.2. Exclusion criteria

Teeth with developmental aberrations, signs of physical trauma or chemical injuries to teeth, presence of class II restorations / crowns and subjects with craniofacial syndromes affecting head size.

Impressions of both the arches were made using alginate impression material which were disinfected using 0.5% sodium hypochlorite and cast bases were made with dental plaster. Measurements were obtained using a digital vernier calliper calibrated to an accuracy of ± 0.02 mm. All the deciduous molar teeth were measured. Mesiodistal width /length of crown (defined as the greatest distance between the contact points on the mesial or distal surface of the tooth crown) and buccolingual width /breadth of crown (defined as the greatest distance between the buccal surface and lingual surface of the tooth crown), of both the deciduous molars was measured in millimetres. The length of the crown was measured using the vernier calliper with the beaks being placed occlusally along the long axis of the tooth at the occlusal third of the tooth crown. For breadth of the crown the beaks of the vernier caliper was held at right angles to the mesiodistal dimension at the middle third of the tooth.[7,8] In case of tooth rotation or malposition, the length was measured between points where it was considered that contact with adjacent teeth would likely have occurred. Tooth crown area (TCA) was calculated using the formula given by Zope et al.[7]

TCA = length of the crown X breadth of the crown

= mesiodistal width X buccolingual width

For head dimensions, the subjects were made to sit in an upright position. Martin spreading calliper was used to measure the head length and head breadth. The length was measured by placing one end of calliper on glabella (the anterior point on the frontal bone midway between the bony brow ridges) and another on opisthocranion point (posterior most point in the midsagittal plane of the occiput) and width was measured as the distance between two most lateral points of the skull above the level of supramastoid crest at right angle to median sagittal plane. While taking the cranial measurements, the hair was compressed as tightly as possible and in case of females, the subjects were asked to lift up the hair falling on the occipital region after which the calliper was placed on the skin over the bony landmarks. This was as per the method by Kalia et al.[9] Cephalic Index (CI) was calculated using the formula given by Thapar et al:[6]

CI = head length / head breadth X 100

Sexual dimorphism was calculated using formula given by Garn and Lewis[10]

Sexual dimorphism= Xm-1 x 100 / Xf

Where Xm = mean tooth value of males and Xf = mean tooth value of females

The data was tabulated and statistically analyzed with SPSS version 22 software using unpaired “t” test. To ascertain the usefulness of absolute measurements of head size and teeth in sex prediction, logistic regression analysis was performed. A p-value of less than 0.05 was considered to be statistically significant.

3. Results

Average mean and its standard deviation of tooth crown area of maxillary deciduous molar between boys and girls is shown in Table 1. Mean difference of 4.00 for maxillary right first deciduous molar and 1.41 for maxillary right second deciduous molar with p value 0.00 was obtained with statistically high significance ($p < 0.05$) and a mean difference of 4.58 for maxillary left first deciduous molar and 1.43 for maxillary left second deciduous molar with p value 0.00 was obtained which was also statistically highly significant. ($p < 0.05$)

Average mean and its standard deviation of tooth crown area of mandibular right and left first and second deciduous molar between boys and girls is shown in Table 2. A mean difference of 3.08 for mandibular right first deciduous molar and 7.23 for mandibular right second deciduous molar with p value 0.00 was obtained with statistically high significance. ($p < 0.05$) and a mean difference of 3.02 for mandibular left first deciduous molar and 7.70 for mandibular left second deciduous molar with p value 0.00 was obtained which was statistically highly significant. ($p < 0.05$)

Table 1: Average mean and its standard deviation of tooth crown area of maxillary right and left first and second deciduous molar

Teeth	Group	Mean	Standard deviation	p value
Maxillary right first deciduous molar	Boys	51.5910	2.08865	0.000**
	Girls	47.5851	1.14850	0.000**
Maxillary right second deciduous molar	Boys	73.6091	1.84501	0.000**
	Girls	72.1907	0.68107	0.000**
Maxillary left first deciduous molar	Boys	51.8505	1.89892	0.000**
	Girls	47.2702	3.65690	0.000**
Maxillary left second deciduous molar	Boys	73.5938	1.82843	0.000**
	Girls	72.1602	0.66098	0.000**

* * = highly significant

Table 2: Average mean and its standard deviation of tooth crown area of mandibular right and left first and second deciduous molar

Teeth	Group	Mean	Standard deviation	p value
Mandibular left first deciduous molar	Boys	56.0515	1.74582	0.000**
	Girls	53.0291	1.00089	0.000**
Mandibular left second deciduous molar	Boys	89.8169	2.72103	0.000**
	Girls	82.1161	1.17435	0.000**
Mandibular right first deciduous molar	Boys	56.1103	1.79702	0.000**
	Girls	53.0209	1.02159	0.000**
Mandibular right second deciduous molar	Boys	89.3239	2.54217	0.000**
	Girls	82.0844	1.17643	0.000**

* * = highly significant

Average mean and its standard deviation of cephalic index between boys and girls is shown in Table 3. Boys showed a mean of 114.72 (± 8.93 SD) and girls showed a mean of 110.73 (± 12.45 SD). On comparison mean difference of 3.99 with p value 0.002 was obtained which was statistically highly significant. ($p < 0.05$).

Table 3: Average mean and its standard deviation of cephalic index

Group	Mean	Standard deviation	p value
Boys	114.7267	8.93969	0.002**
Girls	110.7333	12.45161	0.002**

* * = highly significant

Table 4 depicts the percent sexual dimorphism of tooth crown area and cephalic index between boys and girls. The highest percent sexual dimorphism was showed by maxillary left first deciduous molar (11.83%) and least was showed by maxillary right and left second deciduous molar. (1.96%) respectively.

The sex differentiation accuracy of absolute measurements of cranial and teeth parameters individually using logistic regression analysis is shown in Table 5. The head length gave the best accuracy (88.7%) among cranial parameters while in tooth crown area, the best accuracy was given by mandibular left second deciduous molar (97.7%) amid the teeth variables evaluated.

Table 4: The percent sexual dimorphism of tooth crown area and cephalic index between boys and girls

Teeth	Percent sexual dimorphism
Maxillary right first deciduous molar	10.4%
Maxillary right second deciduous molar	1.96%
Maxillary left first deciduous molar	11.83%
Maxillary left second deciduous molar	1.96%
Mandibular left first deciduous molar	5.69%
Mandibular left second deciduous molar	9.37%
Mandibular right first deciduous molar	5.82%
Mandibular right second deciduous molar	8.81%
Cephalic index	3.6%

4. Discussion

Forensic odontology or forensic dentistry is one of the most fascinating yet unexplored branches of forensic sciences. It primarily deals with the identification of individuals, based on the recognition of unique features present in one's dental structures.[11]

Sex determination is a part of forensic odontology and plays a crucial role when visual identification of the individual is not possible. Morphological and molecular

Table 5: The sex differentiation accuracy of absolute measurements of cranial and teeth parameters individually using logistic regression analysis

Group	Boys		Girls		All
	No.	%	No.	%	%
Head length	133/17	88.7%	17/133	88.7%	88.7%
Head width	133/17	88.7%	20/133	86.7%	87.7%
Mandibular left second deciduous molar	143/7	95.3%	0/150	100%	97.7%

analysis can be done for sex determination. The former can be done on hard or soft tissues of oral and perioral regions.[12]

Forensically, teeth are generally used for estimation of age and determination of gender. Of these approaches to determine gender, the former is predicated on a visible assessment of the form or relative proportions of sexually dimorphic features. The latter being a metric approach, is more advantageous over the visual approach due to it being inherently more objective thus providing higher reliability. Also, this approach is less determined by the previous observer experience, and is more promptly corrigible to statistical analysis, and therefore, helps comparisons within the samples as well as with previous studies.[13]

Tooth crown area is a composite measurement which is based on two independent (orthogonal) measurements of the tooth, which provides a more precise measurement of tooth size than a single measurement.[14]

Ditch LE and Rose JC[6] was the pioneer to recommend the application of tooth measures to identify gender. Deciduous teeth have an advantage for this purpose because other sexually dimorphic traits are not well developed in children and also because teeth are better preserved than skeletal structures. If sexual dimorphism is present in the primary dentition, it could be used to determine the sex of individuals between 11 months and 12 years of age when fully formed primary crowns are present in the crypts of tooth or in the oral cavity.[7]

Children of age three to five years with complete primary dentition were included in the study because the primary dentition stage which begins with the eruption of the lower central incisors at the age of 6 months, is fully established at the age of 3 years, whereas the first permanent molars erupt around the age of six years.[15]

This study showed there was a statistically high significance difference between boys and girls in cephalic index and tooth crown area.

The study, conducted by GarciaGodoy F,[16] found the buccolingual dimensions for all deciduous teeth in girls out sized the boys, where the lower canine showed a statistically significant difference. Coughlin JW[17] noted that buccolingually, females had larger prenatal primary molar crown than boys. Barberia E[18] reported no significant gender differences in the buccolingual dimensions of any molar. Eswara K[19] concluded that the greatest sexual dimorphism was seen for the buccolingual dimensions and the children generally had larger primary molar size.

In our study, significant sexual dimorphism with observed in cephalic index. This was in contradiction to the study done by Thapar et al[5] where no difference in cephalic index was obtained which could be attributed to an evolutionary pattern related to complex interactions in the population. Furthermore, it appears that since the cephalic index is a ratio, it does not reflect the existing sexual dimorphism in the absolute measurements (HL and HB) from which it is derived, however, when the potential for sexual discrimination using these absolute cranial parameters was evaluated by a logistic regression analysis (LRA); Head length showed a high sexing accuracy of 79.9%, followed by head width (68%), while skull index showed the lowest accuracy (53.5%). This result is in accordance to that of Vodanovic[20] who found that head length is considered to be one of the best metric variables for sex determination for Caucasians. In another study by Deshmukh,[21] 32.41% of skulls were correctly sexed by univariate analysis and 87.84% by multivariate analysis, with head circumference being the most dependable parameter for sexual dimorphism. Using this multivariate analysis, Song[22] found that the accuracy of skull sexing was 96.7% for Chinese skulls, 86% by Steyn[23] for white South African skulls, 89.7% by Hanihara[24] on Japanese skulls and 85.5% by Giles[24] on American skulls.

In this study, a logistic regression analysis (LRA) was performed, with head length yielding the best precision (88.7%) among cranial parameters, to determine the usefulness of absolute measures of head and tooth size in predicting sex, while in the area of the tooth crown, the best precision was achieved with the second left mandibular primary molar. (97.7%) Few studies have evaluated odontometric effectiveness in sexing Native Americans, and effectiveness has ranged from 75% using stepwise discriminant analysis[25,26] to, an astonishing 100% success rate established by Acharya[12] by LRA. When using all upper jaw variables, the gender discrimination potential was 73% in this study and 61% for the lower jaw teeth, while both together with LRA showed an efficacy of 76%. This was comparatively lower than what was seen by Acharya.[12]

Several studies have been conducted around the world to assess gender in a variety of bones and teeth individually using different statistical approaches, but there are no relevant data in the literature on gender determination using both the parameters in the pediatric sex determination population.

5. Conclusion

In the emerging field of forensic odontology, skull anthropometry and odontometry is beneficial for sex estimation. Further research is warranted with larger sample size in the direction of definite improvement in the accuracy of sex determination.

6. Source of Funding

None.

7. Conflict of Interest

None.

References

1. Krishan K. Anthropometry in Forensic Medicine and Forensic Science-'Forensic Anthropometry': The Internet. *J Forensic Sci*. 2007;2(1):1–8.
2. Shamim T. Forensic pediatric dentistry. *J Forensic Dent Sci*. 2018;10(3):128–31.
3. Fernandes L, Veloso C, Oliveira J, Genu PR, Santiago BM, Rabello PM. Odontometric analysis of molars for sex determination. *Braz J Oral Sci*. 2016;15(1):35–43.
4. Kieser JA. Human Adult Odontometrics: The Study of Variation in Adult Tooth Size. Cambridge University Press; 2008.
5. Iscan MY, Kedici PS. Sexual variation in bucco-lingual dimensions in Turkish dentition. *Forensic Sci Int*. 2003;137(2-3):160–4.
6. Thapar R, Punnya V, Hallikerimath AS, Kale AD. Sex assessment using odontometry and cranial anthropometry: evaluation in an Indian sample. *Forensic Sci Med Pathol*. 2012;8(2):94–100.
7. Zope A, Bamane S, Khalekar Y, Deore R, Holikatti K, Deore S. Prediction of body weight and body mass index from tooth crown area: A preliminary study. *J Int Oral Health*. 2016;8(2):272–5.
8. Acharya AB, Mainali S. Are dental indexes useful in sex assessment? *J Forensic Odont*. 2008;27(2):53–9.
9. Eboh DEO. A dimorphic study of maxillary first molar crown dimensions of Urhobos in Abraka, South-Southern Nigeria. *J Morphol Sci*. 2012;29(2):96–100.
10. Garn SM, Lewis AB, Kerewsky RS. Buccolingual size asymmetry and its developmental meaning. *Angle Orthod*. 1967;37(3):186–93.
11. Kalistu SN, Doggalli N. Gender Determination by Forensic Odontologist: A Review of various methods. *J Dent Med Sci*. 2016;15(1):78–85.
12. Acharya AB, Prabhu S, Muddapur MV. Odontometric sex assessment from logistic regression analysis. *Int J Legal Med*. 2011;125(2):199–204.
13. Kaushal S, Patnaik V, Agnihotri G. Mandibular canines in sex determination. *J Anat Soc India*. 2003;52:119–24.
14. Moorrees CF, Thomsen SO, Jensen E, Kai-Jen PY. Mesiodistal crown diameters of the deciduous and permanent teeth in individuals. *J Dent Res*. 1957;36(1):39–47.
15. Ash MM, Nelson SJ. Wheeler's Dental Anatomy, Physiology, and Occlusion. St. Louis: Elsevier; 2003. p. 35.
16. Garcia-Godoy F, Michelen A, Townsend G. Crown diameters of the deciduousteeth in Dominican Mulatto children. *Hum Biol*. 1985;57(1):27–31.
17. Coughlin JW. Sex Differences in the prenatal human deciduous molar crown. *J Dent Res*. 1967;46(3):554–8.
18. Barberia E, Suarez MC, Villalon G, Maroto M, Garcia-Godoy F. Standards for mesiodistal and buccolingual crown size and height of primary molars in a sample of Spanish children. *Eur J Paediatr Dent*. 2009;10(4):169–75.
19. Eswara K, Avula JSS, Mallela GMK, Enuganti S, Margana J, Kakarla P. Deciduous molar sizes and sexual dimorphism: South Indian study. *J Paediatr Dent*. 2014;2(1):13–9.
20. Vodanovic M, Demo Z, Njemirovskij V, Keros J, Brkic H. Odontometrics: a useful method for sex determination in an archaeological skeletal population. *J Archaeol Sci*. 2007;34(6):905–13.
21. Deshmukh AG, Devershi DB. Comparison of cranial sex determination by univariate and multivariate analysis. *J Anat Soc India*. 2006;55:48–51.
22. Song HW, Lin ZQ, Jia JT. Sex diagnosis of Chinese skulls using multiple stepwise discriminant function analysis. *Forensic Sci Int*. 1992;54(2):135–40.
23. Steyn M, Iscan MY. Sexual dimorphism in the crania and mandibles of South African whites. *Forensic Sci Int*. 1998;98(1-2):9–16.
24. Giles E, Elliot G. Sex determination by discrimnant function analysis of crania. *Am J Phys Anthropol*. 1963;21(1):53–68.
25. Acharya AB, Mainali S. Univariate sex dimorphism in the Nepalese dentition and the use of discriminant functions in gender assessment. *Forensic Sci Int*. 2007;173(1):47–56.
26. Prabhu S, Acharya AB. Odontometric sex assessment in Indians. *Forensic Sci Int*. 2009;192(1-3):129.

Author biography

Safina Masroor, Senior Lecturer

Nagaveni N.B, Professor

Poornima P, Professor and Head

Cite this article: Masroor S, Nagaveni N.B, Poornima P. Identification of dental sexual dimorphism in deciduous teeth using craniometry and odontometry: A cross sectional study. *Int J Oral Health Dent* 2023;9(1):5-9.