Original Research

# Sexual dimorphism in the permanent maxillary first molar in a population of Maharashtrian ancestry: A cross-sectional study

Vibhuti Shreesh Mhatre, Jigna Pathak[1], Sheetal Choudhari[2], Niharika Swain[1], Sneha Masne Deshpande[3], Prachiti Terni[4]

Department of Oral Pathology and Microbiology, YMT Dental College and Hospital, Navi Mumbai, Maharashtra, [1]Department of Oral Pathology and Microbiology, MGM Dental College and Hospital and MGMIHS, Navi Mumbai, Maharashtra, [2]Department of Oral Pathology and Microbiology, YMT Dental College and Hospital, Navi Mumbai, Maharashtra, [3]Department of Oral Pathology and Microbiology, Bharati Vidyapeeth (Deemed to be University) Dental College and Hospital, Navi Mumbai, Maharashtra, [4]Department of Prosthodontics and Crown and Bridge, Prosthodontics and Crown and Bridge, MGM Dental College and Hospital, Navi Mumbai, Maharashtra, India

## Abstract

**Introduction:** Teeth, being the most stable tissues in the body, can serve as excellent sources in forensic investigations. Tooth size standards based on odontometric investigations can be used for sex determination. The aim of this study was to evaluate the existence of sexual dimorphism in the buccolingual and mesiodistal dimensions of permanent maxillary first molars in a population of Maharashtrian ancestry.

**Materials and methods:** This study was conducted on 200 subjects (100 males and 100 females) of the Maharashtrian population, in the age group of 18–25 years. The buccopalatal (BP) and mesiodistal (MD) diameters of the maxillary first molars were measured using digital vernier callipers on the study casts.

**Results:** Unpaired *t*-tests and paired *t*-tests were used to analyse the data. There was a statistically significant sexual dimorphism ($P < 0.01$) in the permanent maxillary first molar dimensions in the Maharashtrian population.

**Conclusion:** Sexual dimorphism in permanent maxillary first molars may serve as a supplementary tool in sex determination and also provide population-specific baseline data.

**Keywords:** Buccolingual (BL) dimension, maxillary first molar, mesiodistal (MD) dimension, sexual dimorphism

**Address for correspondence:** Dr. Jigna Pathak, Department of Oral Pathology and Microbiology, MGM Dental College and Hospital and MGMIHS, Junction of NH4 and Sion- Panvel Highway, Sector 18, Navi Mumbai – 410 209, Maharashtra, India.
E-mail: drjignapathak@gmail.com

**Submitted:** 01-Oct-2024, **Revised:** 04-Dec-2024, **Accepted:** 05-Dec-2024, **Published:** 31-Dec-2024

## INTRODUCTION

Sexual dimorphism indicates systematic morphologic differences between males and females of the same species that aid in the determination of sex in forensic investigations.[1] Determination of sex from skeletal remains forms an integral part of forensic examinations, as it is the initial stage in the identification of mutilated human remains during mass fatality circumstances where the bodies are beyond recognition.[2] Hence, a reliable method

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Quick Response Code:

Website: https://journals.lww.com/JPAT/

DOI: 10.4103/jomfp.jomfp_286_24

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**How to cite this article:** Mhatre VS, Pathak J, Choudhari S, Swain N, Deshpande MS, Terni P. Sexual dimorphism in the permanent maxillary first molar in a population of Maharashtrian ancestry: A cross-sectional study. J Oral Maxillofac Pathol 2024;28:731-5.

to establish the sex of the deceased is of paramount importance.

Teeth are the hardest, most enduring, and chemically the most stable structures in the body, withstanding bacterial deterioration and fire.[3,4] Hence, teeth could be used as a reliable source in anthropology, palaeontology, genetics, and human identification.[2]

The determination of sex, which is an important parameter in human identification, can be analysed using dental and osteological remains. There are three commonly used methods for sex determination: 1) Nonmetric, 2) Morphometric, and 3) Biochemical evaluation. The non-metric method includes morphologic evaluation of characteristics of teeth and bones, morphometric evaluation comprises the measurement of certain quantifiable aspects of teeth and bones, and biochemical evaluation encompasses DNA[5] or Barr bodies analysis.[6] Non-metric methods can be subjective, and biochemical evaluation is not cost-effective. Therefore, morphometric evaluation remains the most feasible alternative for gender determination, especially in mass disasters.

Tooth size standards (morphometric parameter) can be economic and beneficial in the determination of age and sex.[7] Prediction of sex becomes simplified with such tooth size standards. The permanent mandibular canines have shown the greatest sexual dimorphism in multiple studies done in the past.[8] Besides the permanent mandibular canine, the permanent maxillary central incisors and first molars also reveal sexual dimorphism. Maxillary first molars are early in eruption and less commonly impacted as compared to mandibular canine. Hence, the maxillary first molar (Bucco-lingual (B-L) dimension and medio-distal (M-D) dimension) can be immensely helpful as an odontometric tool.[9] Furthermore, sex determination in adults can be relatively easier if the postcranial skeleton is intact. However, in young children, sex determination from the skeleton can be difficult.[10] The odontometric characteristics of teeth erupted at an early age can be of great importance in sex in such scenarios.[3]

The structural morphology of male and female teeth is similar. However, cultural, environmental, ethnic, and genetic factors may influence sexual dimorphism in tooth size.[3]

There is a genetic basis for the magnitude of sexual dimorphism as per inferences of some authors.[11] The extent of sexual dimorphism can vary in different racial groups belonging to particular geographic regions due to genetic influence.[12] Different magnitudes of sexual dimorphism may be associated with complex interactions among genetic and environmental factors.[13] Hence, this study was undertaken to analyse sexual dimorphism in permanent maxillary 1st molars in a population of Maharashtrian ancestry visiting our dental institution.

## MATERIALS AND METHODS

This cross-sectional study was conducted on the maxillary casts of 200 subjects of Maharashtrian ancestry with at least 3 generations on the mother's and father's side[14] (100 males and 100 females) visiting our dental institution, using a convenient sampling technique. There was equal distribution amongst male and female samples, in the age group of 18–25 years. The observer was blinded to the selection process. Informed consent was obtained from all the subjects who met the following inclusion and exclusion criteria.

### Inclusion criteria

Maharashtrians with at least 3 generations on the mother's and father's side[14] with

- Healthy state of periodontium
- Caries free teeth
- Presence of bilateral maxillary first molars.

### Exclusion criteria

- Individuals with missing maxillary first molars
- Individuals with any periodontal pathology
- Individuals not consenting to participate in the study.

After initial examination, the maxillary impressions were made with alginate impression material, and the casts were prepared with type III dental stone. The measurement of the mesiodistal and buccolingual width of the maxillary first molar was carried out with the help of a digital vernier calliper [Figure 1]. The mesiodistal and buccolingual width were measured three times, the mean was calculated, and the data was entered in a Microsoft Excel sheet. Intra-observer error was evaluated to check the reliability

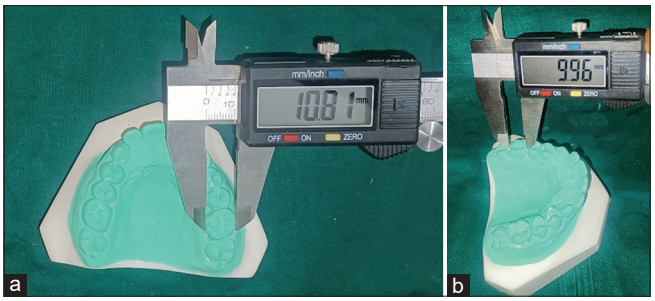


**Figure 1:** (a and b) Recording of labiolingual and mesiodistal dimension of the maxillary first molar with the help of a digital vernier calliper

of the measurements by measuring the width at a different time on 100 randomly selected teeth and minimizing the error.

Comparison of buccolingual and mesiodistal width (Right and left) values in terms of mean (SD) between males and females was done using 'unpaired *t* test'. Comparison of buccolingual width and mesiodistal width values of males and females between right and left side in terms of mean (SD) was done using 'paired *t* test'. Percentage of Sexual Dimorphism in Maxillary first molars was calculated by the following formula.[15]

$$\text{Sexual dimorphism} = (Xm/Xf) - 1 \times 100$$

Sexual dimorphism is the percentage value by which the male tooth dimension is greater than the female tooth dimension. This formula is given by Garn (1967).

The approval from the ethics committee was obtained. The date of the approval is 27th Jan 2022.

## OBSERVATIONS AND RESULTS

The mean age of males was 22.39 years ± 2.44 years and that of females was 21.98 years ± 2.58 years. The parameters buccolingual and mesiodistal dimension were measured on the study casts in males and females using digital vernier calliper.

Comparison of the buccolingual width (BLW) on both left and right sides between males and females using unpaired *t* test showed statistically significant difference in the mean values of BL-L and BL-R between males and females. Comparison of mesiodistal width (MDW) on both left and right sides between males and females using unpaired *t* test showed statistically significant difference in the mean values of MD-L and MD-R between males and females (*P* value <0.001) [Table 1].

Comparison of buccolingual (BL) and mesiodistal (MD) width between left and right sides using paired *t* test in males showed mean values greater on right side than on left side. In contrast, comparison of BL and MD width between left and right sides using paired *t* test in females showed mean values greater on left side than on right side. There was a statistically significant difference in buccolingual dimension (BL) of BL-R and BL-L values of females [Table 2].

Percentage of sexual dimorphism in permanent maxillary first molars was highest on the right side in terms of buccolingual dimensions (5.51%) followed by mesiodistal dimension on the right side itself (4.75%). Left sided permanent maxillary first molars showed percentage of sexual dimorphism of 4.20% and 4.01% in the buccolingual and mesiodistal dimensions respectively [Table 3].

## DISCUSSION

Dental morphological characteristics are important in genetic studies and in understanding variation within and among species. Dental antemortem records have been beneficial in providing concrete evidences in forensic investigations in the past. Thus, dental morphometric characteristics, like mesiodistal and buccolingual dimensions of teeth, can be used as reliable methods in sex identification. Many studies carried out in various populations have demonstrated the existence of sexual dimorphism, and it can be measured by using dental dimensions.[3,4] Hence, we undertook this research on a population of Maharashtrian ancestry.

Our study revealed that the mean mesiodistal width of maxillary first molar was 9.92 mm on right side and

**Table 1: Comparison of buccolingual and mesiodistal width (Right and left) values in terms of mean (SD) between males and females using an unpaired *t*-test**

| | Gender | *N* | Mean | Std. Deviation | *t* | *P* |
|---|---|---|---|---|---|---|
| *BL-R* | Male | 100 | 11.26 | 0.68 | 6.79 | <0.001** |
| | Female | 100 | 10.67 | 0.54 | | |
| *BL-L* | Male | 100 | 11.20 | 0.72 | 5.21 | <0.001** |
| | Female | 100 | 10.75 | 0.49 | | |
| *MD-R* | Male | 100 | 9.92 | 0.56 | 5.65 | <0.001** |
| | Female | 100 | 9.47 | 0.58 | | |
| *ML-L* | Male | 100 | 9.89 | 0.54 | 5.01 | <0.001** |
| | Female | 100 | 9.52 | 0.54 | | |

*P*<0.05 - Significant*, *P*<0.001 - Highly significant**

**Table 2: Comparison of buccolingual width and mesiodistal width values of males and females in terms of mean (SD) between the right and left side using the paired *t*-test**

| Males | | *N* | Mean | Std. Deviation | *t* | *P* |
|---|---|---|---|---|---|---|
| Males | *BL-R* | 100 | 11.26 | 0.68 | 1.91 | 0.059 |
| | *BL-L* | 100 | 11.20 | 0.72 | | |
| Males | *MD-R* | 100 | 9.92 | 0.56 | 0.76 | 0.453 |
| | *MD-L* | 100 | 9.89 | 0.54 | | |
| Females | *BL-R* | 100 | 10.67 | 0.54 | 2.81 | 0.006* |
| | *BL-L* | 100 | 10.75 | 0.49 | | |
| Females | *MD-R* | 100 | 9.47 | 0.58 | 1.34 | 0.183 |
| | *MD-L* | 100 | 9.51 | 0.54 | | |

*P*<0.05 - Significant*, *P*<0.001 - Highly significant**

**Table 3: Percentage of sexual dimorphism in maxillary first molars**

| Variable | Percentage |
|---|---|
| *BL-R* | 5.51% |
| *BL-L* | 4.20% |
| *MD-R* | 4.75% |
| *MD-L* | 4.01% |

9.89 mm on left side in males, while it was 9.47 mm on right side and 9.51 mm on left side in females. The mean buccolingual width of maxillary first molar was 11.25 mm on right side and 11.20 mm on left side in males; while in females it was 10.66 mm on right side and 10.75 mm on left side. The comparison of mean values of mesiodistal and buccolingual dimensions between males and females showed that males have significantly higher values as compared to females ($P < 0.001$). Our findings are consistent with other studies by V. Sonika[3] on Haryana Population, Dahal S *et al*.[4] on Nepali population, Mehta S *et al*.[16] on Ganganagar population, Agnihotri and Sikri[17] on Jat Sikh population, Singla *et al*.[18] on Himachal population, Sharma P *et al*.[19] on North Indian population, Shireen A[20] on Gulbarga population which also reported that males have larger teeth than females with statistically significant differences. The larger sized teeth in males can be due to larger thickness of dentin in males than females. This can be related to Y chromosome having more mitotic potential inducing dentinogenetic; in contrast to X chromosome inducing amelogenesis.[21]

The findings of our study differ from the study by Eboh[22] on Urhobos population in South-Southern Nigeria in which the left mesiodistal dimensions of maxillary 1st molar and a study by Phulari *et al*.,[23] in which the difference in both right and left mesiodistal dimensions of maxillary 1st molar between males and females was statistically insignificant. While, in a study performed by Sah SK *et al*.[24] on Eastern Nepal population, the difference in both buccolingual and mesiodistal dimensions of maxillary 1st molar between males and females was statistically insignificant, though each of the above study reported higher mean values in males than in females.

In our study, the mean values of both MD and BL parameters in males were greater on the right side than on the left, while in females, the mean values were greater on the left side than on the right side. When compared to other studies, V. Sonika[3] showed mean MD and BL parameters greater on the left side in both males and females in Haryana Population. Eboh[22] reported BL parameters greater on the left side in both males and females in Urhobos population, while greater right sided MD parameters in males and greater left sided MD parameters in females. Sah SK *et al*.[24] reported both MD and BL parameters higher in right sided teeth in both the sexes in Eastern Nepal population. Agnihotri and Sikri[17] reported mean parameters greater on the left side. Differences between right and left can be due to dental asymmetry; as bilateral body symmetry seldom exists in the living organisms.[3]

The permanent right maxillary first molar showed greatest percentage of sexual dimorphism in terms of buccolingual dimensions (5.51%) in our study. Our study results were in agreement with studies by Sah SK *et al*.[24] which reported highest sexual dimorphism of 5.24% in right maxillary 1st molar in terms of mesiodistal dimension in Eastern Nepal population. A study by Eboh[22] on Urhobos population recorded sexual dimorphism of 3% in right maxillary 1st molar in both MD and BL dimensions and also of 3% in left maxillary 1st molar in terms of BL dimension. In contrast, a study by V. Sonika *et al*.,[3] the left maxillary first molar was found to exhibit the greatest sexual dimorphism (5.54%) in terms of buccolingual dimension in Haryana population. While, a study by Dahal S *et al*.[4] could not establish sexual dimorphism in maxillary 1st molar in Nepali population.

The method employed in our study is simple and inexpensive and therefore can be useful in forensic odontology for identification of sex of an individual belonging to a specific population.

### Limitations

Sex determination through odontometric analysis is currently not a legislate evidence in the court of law. Larger sample size may be helpful in establishing a reliable and valid baseline data for a population of Maharashtrian ancestry, which may, in combination with other accessary tools (palatal rugoscopy, cheiloscopy, amyloglyphics, and measurement of other metric/non-metric parameters) may aid in using this odontometric data in population identification of a specific racial group.

## CONCLUSION

The buccolingual and mesiodistal dimensions of maxillary first molar in males and females had statistically significant differences on both the right and the left sides of the jaw. Hence, the present study established the existence of statistically significant sexual dimorphism in maxillary first molars in the Maharashtrian population, but larger sample size may be required to validate this. Also, it is best to combine several different methods, whenever possible, in order to increase the reliability in determining sex of an individual. Homogeneous sample selection based strictly on ancestry should be emphasized in order to have comparable baseline values of tooth dimensions of specific racial group, as this may be valuable in the future research on population identification based on odontometric data.

### Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

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