EUROPEAN JOURNAL OF BIOMEDICAL AND PHARMACEUTICAL SCIENCES
http://www.ejbps.com

ISSN 2349-8870
Volume: 12
Issue: 4
Year: 2025

GENDER DETERMINATION FROM THE MESIODISTAL DIMENSION OF PERMANENT MAXILLARY INCISORS AND CANINES AMONG JORDANIAN POPULATIONS

Moath Quftan Momani[1]*, Zaid Ali Al Zyoud[2], Saleem Saleh Ali[3], Mohammad Abedel Haleem Abu Hazeem[4] and Suhaib Abdlkarim Al Rwashdeh[5]

[1,4]Department of Prosthdontic.
[2,3,5]Department of Restorative Dentistry.

***Corresponding Author: Moath Quftan Momani**
Department of Prosthdontic.

Article Received on 13/02/2025 **Article Revised on 03/03/2025** **Article Accepted on 23/03/2025**

ABSTRACT

Introduction: One of the primary objectives of forensic dentistry is the identification of living or deceased individuals through the unique characteristics of their teeth. Gender is among the key identification criteria that need to be determined. Compared to other skeletal components, the mineralized structures of teeth withstand intentional, inadvertent, or natural changes with very little degeneration after death. Teeth size measurements obtained from odontometric research conducted on a certain population can be an important means of identifying gender. **Aims and Objectives:** The goal is to assess and ascertain the precision of utilizing permanent maxillary incisors and canines in determining gender. **Materials and Methods:** The research involved 200 participants, comprising (100 males and 100 females) Jordanians with intact maxillary anterior teeth (age range= 15-35 years). Mesiodistal dimensions of the maxillary anterior teeth on the dental casts were measured using a digital vernier calipers (Fuzhou conic industrial co. LTD, China) in millimeters.

KEYWORDS: Anterior teeth, mesiodistal dimension, sexual dimorphism.

1. INTRODUCTION

According to Keiser-Neilson's definition from 1970, forensic dentistry, also known as forensic odontology, is the area of forensic medicine that is devoted to the ethical handling, examination, and presentation of dental discoveries for legal purposes. Teeth are remarkably resilient; they can withstand environmental damage such as fire and organic decay better than other skeletal systems.[1,2]

The systemic variation in form (either in size or shape) between individuals of different sexes within the same species is known as sexual dimorphism. It is known that teeth from different animals display sexual dimorphism.[13] In modern human groups, males have larger dentitions than females.

The primary methods for determining a person's sex using dental features are comparisons of the measurements of the teeth in males and females, as well as comparisons of the frequencies of nonmetric dental traits such as Carabelli's trait of upper molars. Based on dental measures, the two most often used and studied traits for sex determination are the buccolingual and mesiodistal diameters of the permanent tooth crown.[14]

In a research on the mesiodistal dimensions of the permanent and deciduous teeth in the Southern Chinese population, Yuen et al. discovered that three permanent teeth and none of the primary teeth showed appreciable sex variations in size. For the primary teeth, the percentage of sexual dimorphism varied from 0.06% to 1.97%, whereas for the permanent teeth, it varied from 0.36% to 5.27%.[12] Teeth not only last into death but also maintain a mostly unaltered structural integrity over an extended period of time, making them the most resilient portion of the body with the least amount of natural structural turnover. When forensic odontologists are educated to work with human dentallong-bone dimensions, pelvic structures, etc., typically ranges from 96 to 100%, dental identification becomes particularly crucial in cases of severe body.[3]

Given the distinct features of every person's mouth, sexual dimorphism—which includes differences in size, stature, and look between males and females—is an important idea that also applies to dental identity. A number of studies have provided ample evidence of sexual dimorphism in permanent teeth.[4]

Consequently, this is quite significant in the field of forensic medicine. Teeth can be used to determine gender based on measurements of the buccolingual and mesiodistal areas. Using teeth to determine sex becomes especially important in young people whose skeletal secondary sexual traits have not yet fully developed.[6]

The goal of the current study is to investigate whether sexual dimorphism exists in the mesiodistal dimension of canines and permanent maxillary incisors, and whether this information is relevant for sex determination in the Jordanian population.

2. MATERIALS AND METHODS

The Royal Medical Services Ethics Committee provided ethical approval. Every participant in this study provided written informed permission. When the subjects are younger than eighteen, the parents or legal guardians of each patient provided written informed consent.

2.1 Study design and sample

The cross-sectional study was conducted during the period October2023 to June 2024. With sample size of 200 Jordanians(100 males and 100 females) aged between 15 and 35 years. The participants were selected from among the daily patients treated at our department, situated in Jordan. To detect a significant 10% difference between the two groups by using the chi-square test, based on $\alpha = 0.05$ and 80% power.

Calculate Chi-Square Test Statistic

- $\chi 2 = \sum \left(\frac{O-E}{E} \right) 2$
- Where:
- $2\chi 2$ = Chi-square test statistic
- **O = Observed frequency**
- E = Expected frequency

In this case, there is no difference in the number of male and female participants because they are equal. For the present study, patients meeting the inclusion criteria and undergoing treatment at our department were included in the research. After obtaining consent, a maxillary alginate impression was taken for patients who fulfilled inclusion criteria.

The inclusion criteria comprised the following

1. Morphologically normal permanent teeth located in the maxillary and mandibular jaws.
2. Intact mesiodistal diameter of the crown of the permanent teeth.
3. Teeth exhibiting no gross dental abnormalities.
4. Teeth showing no apparent loss of tooth substance due to attrition or restorations that could affect the mesiodistal diameter of the crown.
5. Healthy state of the gingiva and periodontium.
6. Teeth with no history of prior orthodontic treatment or proximal stripping.

Exclusion criteria

1. person aged above 35 years.
2. Presence of any deciduous (baby) teeth.
3. Congenitally missing teeth in any dental segment.
4. Subjects who had undergone restorative treatment other than Class I occlusal restoration.
5. Clinically evident interproximal dental caries.
6. Dental fracture or fixed prosthesis (crown or bridge).
7. Subjects with a history of any type of orthodontic treatment.
8. Alteration in the number or shape of the teeth.
9. Presence of gingival and periodontal diseases

2.2 Impression and measurements

Alginate impressions were taken using Cavex Cream alginate (Cavex Holland BV, the Netherlands) following standard mixing procedures. The impressions were disinfected by immersing them in a 1:10 sodium hypochlorite solution (Odex Bleach, Spartan Modern Industry Co., Jordan) for 10 minutes. Acceptable impressions were then covered in damp gauze, labeled with a specific patient number representing each participant in the study, and packaged for transport to the laboratory.

In the laboratory, the impressions were immediately poured with type IV dental stone (SSS New Gypstone, San Esu Gypsum Co., China). After the casts had set and been trimmed, they were returned for measurement, with the special patient number retained on each cast. Any casts with defects in the anterior teeth were discarded, and arrangements were made to remake the impressions if necessary.

Measurements of the width of the six upper anterior teeth were conducted using Digital Vernier callipers (Fuzhou Conic Industrial Co., Ltd., China) Image (1), providing precision readings to the nearest 0.01 mm. The clinical crown width was measured, defined as the maximum distance between the contact points of the proximal surfaces of the dental crown, with the callipers held parallel to the occlusal and buccal surfaces.

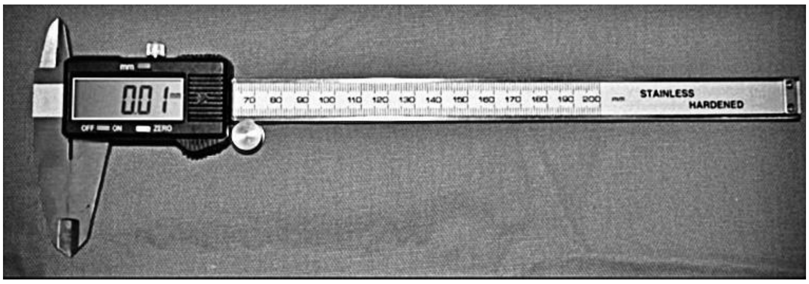

Image 1: Digital Vernier calipers with precision reading to the nearest 0.01 mm.

To minimize error, all measurements were performed by a single examiner to eliminate inter-observer variability. Measurements were repeated at least three times, or until a consistent value was obtained, to avoid intra-observer error. Additionally, measurements were limited to ten casts at a time to mitigate fatigue-related errors.

2.3 Assessment of measurement errors

Before conducting the study, intra-examiner error was assessed by taking two measurements, with a 15-day interval, of 40 randomly selected study casts from the participants. The mean frequencies and standard deviations were calculated. Group comparisons were performed using the unpaired t-test. A significance level of 0.05 was set, and a p-value less than 0.05 was considered significant. Statistical analysis was carried out using the Statistical Package for Social Sciences Software (SPSS® for Windows version 20, SPSS Inc., Chicago, IL, USA).

Random error assessment was established using the index of reliability by correlating repeat measurements (Houston, 1983). Error analysis indicated no significant intra-examiner differences ($p > 0.05$), and correlations of repeat measurements were found to be greater than 0.95, indicating the absence of random error. Additionally, Kappa statistics were employed to assess intra-examiner agreement by correlating repeat measurements, consistent with established methods.

2.4 Statistical analysis

The collected data underwent statistical analysis, and subsequent processing and analysis were carried out using the SPSS software package version 17. To determine the size of the teeth, the range, mean, and standard deviation were calculated. A two-sample t-test and Stepwise Discriminant Function Analysis were conducted as part of the statistical analysis.

3. RESULTS

Table 1 shows the mean value, standard deviation, and P-value of the maxillary incisors and canines for the subjects included in this study (males and females).

The discriminant score was computed using the function coefficients. To assess sex, both dimensions were multiplied by the unstandardized coefficients. The obtained finding was combined with the constant using the following formula:

$y = a + b\,(p1) + b\,(M2)$

a = constant of function between the right and left maxillary central incisors and canines.

b = unstandardized coefficient of that specific tooth.

Table 1: Mean and SD.

Tooth	Mean value Male	Mean value female	SD male	SD female	*P* value
11	8.043	8.5	0.4525	0.2334	0.1412
12	6.247	6.3	1.626	0.2969	0.006
13	8.21	7.5	0.975807	0.565685	0.0217
21	7.785	7.8	0.6576	0.1555	0.1412
22	6.69	6.3	1.796	0.5939	0.0256
23	8.065	7.3	1.1243	0.254558	0.0057

SD – Standard deviation, *values which are significant at 5% level of significance

Table 2a: Accuracy of determination of sex using teeth 13.

Sex Correctly classified Misclassified No. % Age No. % Age
Female 48 52% 52 48%
Male 39 61% 61 39%
Total 87 56.5% 113 43.5%

Table 2b: Accuracy of determination of sex using teeth 23.

Sex Correctly classified Misclassified No. % Age No. % Age
Female 67 33% 33 67%

Male 24 76% 76 24%
Total 91 58% 109 42%

(Table 3) shows the range of the measured mesiodistal dimension of right and left maxillary canines (which shows sexual dimorphism) for both males and females.

Percentage of dimorphism

The percentage of dimorphism is defined as the percentage by which the tooth size of males exceeds that of females.

The percentage of dimorphism for each tooth was calculated using the following formula:

Percentage of dimorphism = $\{(Xm/Xf)-1\} \times 100$

where Xm = mean male tooth dimension; Xf = mean female tooth dimension.

Table 3 shows percent of dimorphism as observed for right and left maxillary canines.

Table 3: Percent of dimorphism.

Tooth	Mean ±SD	*P* value	% Dimorphism
	Male Female		
13	8.21±0.975807 7.5±0.565685	0.0217	1.21%
23	8.065±0.604 7.3±0.254558	0.0057	1.13%

Table 4: The Mean, Median Maximum and Minimum value of the Width, for each tooth separated by gender.

		Canine		lateral		Central	
		left	**right**	**left**	**right**	**left**	**right**
mean	**male**	8.065	8.21	6.69	6.247	8.129	8.043
	female	7.3	7.5	6.3	6.3	7.8	7.8
median	**male**	7.89	8.21	6.69	6.33	7.89	7.785
	female	7.5	7.2	6.1	6.1	8.5	8.2
Stander deviation	**male**	1.1243	0.975807	1.626346	1.796051	0.452548	0.657609
	female	0.254558	0.565685	0.296984848	0.59397	0.233345	0.275772
Minimum	**male**	7.57	7.52	5.54	5.06	7.57	7.32
	female	7.3	6.8	5.9	5.7	8.3	8.1
Maximum	**male**	8.21	8.9	7.84	7.6	8.21	8.25
	female	7.7	7.6	6.3	6.6	8.7	8.2

Table A: Independent Samples T-Test measuring the presence of significant differences in tooth measurements between females and males.

Tooth	Measurment	Statistic	df	P
Left canine	Width	0.9103	198	0.0217
Left lateral incisor	Width	0.7078	198	0.006
Left central incisor	Width	2.609	198	0.0116
Right canine	Width	0.5713	198	0.0057
Right Lateral incisors	Width	0.6595	198	0.0256
Right Central incisor	Width	2.431	198	0.1412

In Table A, the information presents the statistical analysis results obtained from an Independent Samples T Test that compared tooth measurements, between males and females. This test focused on aspects such as width for teeth including left and right canines, lateral incisors and central incisors. The findings indicate that there are larger teeth in males than females. The p values obtained are above the used threshold of 0.05 for statistical significance.

Table X1: Accuracy of determination of sex using teeth 13, by Rajbir Kaur Khangura.[25]

Sex	Correctly classified		Misclassified	
	No.	% Age	No.	% Age
Female	22	44.00	28	56.00
Male	27	54.00	23	46.00
Total	49	49.00	51	51.00

Table X2: Accuracy of determination of sex using teeth 23, Rajbir Kaur Khangura.[25]

Sex	Correctly classified		Misclassified	
	No.	% Age	No.	% Age
Female	30	60.00	20	40.00
Male	30	60.00	20	40.00
Total	60	60.00	40	40.00

So, the percentage of dimorphism for 13 is approximately 1.21% and for 23 is 1.13%. This positive value indicates that, on average, the male tooth dimension is larger than the female tooth dimension.

DISCUSSION

The diversity and distinctiveness of teeth, both in terms of number and morphology within each individual, underscore their significance as identifying features. Teeth are renowned for being unique structures composed of the most resilient mineralized tissues in the human body. Consequently, they exhibit remarkable resistance to various forms of destruction, including mechanical, chemical, physical, and thermal factors. As a result, teeth play a crucial role in the identification of skeletal remains, particularly in scenarios where standard identification methods are rendered impractical due to inadequate preservation of skeletal remains. Gender identification through dental features can be categorized into non-metric and metric methods. Non-metric methods rely on the presence or absence of specific morphological features.

Identification of population groups or ethnicities can be accomplished using non-metric features of the crown and root, such as upper incisor shoveling, cusp of Carabelli, hypocone, and protostylid. On the other hand, metric features rely on tooth measurements. The metric approach for gender estimation is more systematic, less subjective, and can be replicated to validate results. Buccolingual and mesiodistal tooth dimensions can be utilized to determine sex based on differences in tooth size and proportions. Among these dimensions, the mesiodistal and buccolingual diameters of the permanent tooth crown are most studied and utilized for sex determination. In this study, the mesiodistal dimensions of the teeth were directly measured in the subjects by a single operator, with each measurement repeated thrice. Only the mesiodistal width of the teeth was assessed for sexual dimorphism.

There are differences in the odontometric features in different populations, and even within the same population (in the historical and evolutional context). Therefore, determination of specific population values in order to make personal identification possible can be done on the basis of tooth measurements.[8] This study was conducted to evaluate the mesiodistal dimension of the maxillary incisors and canines of the Jordanian for males and females.

According to Doris et al., early permanent dentitions offer the greatest sample for measuring tooth sizes because most people have less attrition and less mutilation in their early adult dentitions. As a result, these factors would have the least impact on the mesiodistal tooth width.[15] Thus, the study sample consisted solely of participants in the 15–35 age range.

The mandibular canine index, the buccolingual dimension of teeth, the height of the tooth, and other odontometric measurements have all been used to estimate sex.[8]

All necessary dental measurements for this investigation were made right on the cast. Measuring the buccolingual width of maxillary incisors and canines under indirect vision proved to be challenging, hence the evaluation of sexual dimorphism was limited to the mesio-distal width of these teeth.

According to the study's univariate analysis, male dentition's M-D dimensions are larger than female dentition's, which is consistent with other research. Male teeth tend to be larger than female teeth for each type of tooth in both arches, according to research by Richardson et al.[16]

Even in cases with adequate occlusion, Sanin and Savara observed variations in crown size patterns.[17] In their investigation, Howe et al. discovered that the combined mesiodistal breadth of males was greater than that of females.[18]

Only the right and left maxillary canines, which are permanent maxillary anterior teeth, showed statistically significant dimorphism in this study. The only teeth that exhibited sexual dimorphism were the canines, according to the 1993 study by Hashim and Murshid.[19]

Garn *et al*., studied the magnitude of sexual dimorphism by measuring the mesiodistal width of the canine teeth and showed that ―the mandibular canine showed a greater degree of sexual dimorphism than the maxillary canine.[20] However, Minzuno reported that maxillary canine showed a higher degree of sexual dimorphism compared to the mandibular canine in a Japanese population.[21]

Pratibha et al. found sexual dimorphism in the maxillary left canine, similar to Iscan's work on Turks.[14] Otuyemi and Noar[16] found bilateral dimorphism in maxillary canines, while Lund and Monstad[22] also found such dimorphism.

The multivariant analysis of the data showed that when combination of values for right and left maxillary canines was taken 64% females were classified correctly and 58% males were classified correctly. However the study conducted by Al-Rifaiy showed that an average of 65.5% individuals could be classified correctly.[23]

Canine dimorphism has been explained by a number of theories.

1. Moss claims that it is due to the larger Males have thicker enamel than females because they go through a longer stage of amelogenesis.[24]
2. Because male maturation is slowed down by Y chromosomes.[11]

Several variables can cause variations in the degree of dimorphism. According to some writers, this variance may result from environmental impacts the size of teeth. Diverse populations' use of varied food sources has been identified as one such environmental factor. Some have proposed that biological forces and cultural factors interact. The difference in the degree of dimorphism can be caused by a complicated interaction between a number of hereditary and environmental factors. Teeth have evolved to act in a variety of ways, according to Garn et al. These behaviors include the reduction of the dentition as a whole and the reduction of one group of teeth in comparison to another.[11]

CONCLUSION

Because of its simplicity and dependability, the study assessed the use of a linear dimension (mesiodistal) of permanent maxillary incisors and canines. According to the study, sex can be determined using the right and left maxillary canines with 68.5% accuracy for males and 45% accuracy for females. Consequently, our study suggests that maxillary canines exhibit strong sexual dimorphism and can be utilized ln conjunction with other recognized methods for determining sex when fragmentary remains from large-scale disasters are found.

REFERENCES

1. Leung CK. Forensic odontology. Hong Kong Med Diary Dent Bull, 2008; 13: 16-20.
2. Jurel SK. Role of dentist in forensic investigations. J Forensic Res., 2012; 3: 148.
3. Grover M, Bai RG, Ram T, Puri PM, Ghodke KR. An odontologist’s key to sex determination: Study analysis of mandibular canine teeth in south Indian population. J Orofac Res., 2013; 3: 157-60.
4. Vishwakarma N, Guha R. A study of sexual dimorphism in permanent mandibular canines and its implications in forensic investigations. Nepal Med Coll J., 2011; 13: 96-9.
5. Galdames IS, López MC, Farías BL, Marchant CS, Muñoz ST, Rojas PG, et al. Sexual dimorphism in mesiodistal and bucolingual tooth dimensions in Chilean people. Int J Morphol., 2008; 26: 609-14.
6. Hemanth M, Vidya M, She y N, Karkera BV. Sex determination using dental tissue. Medico-Legal Update, 2008; 8: 7-12.
7. Astete JC, San Pedro VJ, Suazo GI. Sexual dimorphism in the tooth dimensions of Spanish and Chilean peoples. Int J Odontostomat, 2009; 3: 47-50.
8. Vodanović M, Demo Ž, Njemirovskij V, Keros J, Brkić H. Odontometrics: A useful method for sex determination in an archaeological skeletal population? J Archaeol Sci., 2007; 34: 905-13.
9. Rajendran R, Sivapathasundharam B. Forensic odontology. In: Rajendran R, editor. Shafer’s Textbook of Oral Pathology. 6th ed. New Delhi: Elsevier India, 2009; 880-2.
10. Bidmos MA, Gibbon VE, Štrkalj G. Recent advances in sex identification of human skeletal remains in South Africa. S Afr J Sci., 2010; 106: 238. Available from: h p://www. sajs.co.za/sites/default/fi les/publications/pdf/238-3116- 4-PB.pdf
11. Acharya AB, Mainali S. Sex discrimination potential of buccolingual and mesiodistal tooth dimensions. J Forensic Sci., 2008; 53: 790-2.
12. Yuen KK, So LL, Tang EL. Mesiodistal crown diameters of the primary and permanent teeth in Southern Chinese-a longitudinal study. Eur J Orthod., 1997; 19: 721-31.
13. Dahberg AA. Dental traits as identification tools. Dent Prog., 1963; 3: 155-60.
14. Iscan MY, Kedici PS. Sexual variation in bucco-lingual dimensions in Turkish dentition. Forensic Sci Int., 2003; 137: 160-4.
15. Doris JM, Bernard BW, Kuftinec MM, Stom D. A biometric study of tooth size and dental crowding. Am J Orthod., 1981; 79: 326-36.
16. Richardson ER, Malhotra SK. Mesiodistal crown dimension of the permanent dentition of American Negroes. Am J Orthod., 1975; 68: 157-64.
17. Sanin C, Savara BS. An analysis of permanent mesiodistal crown size. Am J Orthod., 1971; 59: 488-500.
18. Howe RP, Mc Namara JA Jr, O’Connor KA. An examination of dental crowding and its relationship to tooth size and arch dimension. Am J Orthod., 1983; 83: 363-73.
19. Hashim MA, Murshid ZA. Mesiodistal tooth width: A comparision between Saudi males and females, part1. Egypt Dent., 1993; 39; 343-6.
20. Garn SN, Lewis AB, Swindler DR, Kerewsky RS. Genetic control of sexual dimorphism in tooth size. J Dent Res., 1967; 46: 963-72.
21. Minzuno O. Sex determination from maxillary canine by fourier analysis. Nihon Univ Dent J., 1990; 2: 139-42.
22. Lund H, Monstad H. Gender determination by odontometrics in Swedish population. J Forensic Odontostomatol., 1999; 17: 30-4.
23. Al-Rifaiy MQ, Abdullah MA, Ahraf I, Khan N. Dimorphism of mandibular and maxillary canine teeth in establishing sex identity. Saudi Dent J., 1997; 9: 17-20.
24. Vito CD, Sauders SR. A discriminant function analysis of deciduous teeth to determine sex. J Forensic Sci., 1990; 35: 845-58.
25. Rajbir Kaur Khangura, Keya Sircar, Sanjeet Singh, Varun Rastogi. Sex determination using mesiodistal dimension of permanent maxillary incisors and canines. Journal of Forensic Dental Sciences / July-December 2011 / Vol 3 / Issue 2.