Original Article

Comparative evaluation of arch form among the Nepalese population: A morphological study

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Abstract

Aims: The study aims to identify sexual dimorphic features in the arch patterns based on tooth arrangement patterns and the maxillary and mandibular arches using Euclidean Distance Matrix Analysis (EDMA).

Settings and Design: A total of 96 Nepalese subjects, aged 18 to 25 were assessed using casts and photographs.

Materials and Methods: Thirteen landmarks representing the most facial portions of the proximal contact areas on the maxillary and mandibular casts were digitised. Seventy-eight possible, Euclidean distances between the 13 landmarks were calculated using the Analysis ToolPak of Microsoft Excel®. The male-to-female ratios of the corresponding distances were computed and ratios were compared to evaluate the arch form for variation in the genders, among the Nepalese population.

Statistical Analysis Used: Microsoft Excel Analysis ToolPak and SPSS 20.0 (IBM Chicago) were used to perform EDMA and an independent *t*-test to compare the significant differences between the two genders.

Results: The maxillary arch's largest ratio (1.008179001) was discovered near the location of the right and left lateral incisors, indicating that the anterior region may have experienced the greatest change. The posterior-molar region is where the smallest ratio was discovered, suggesting less variation. At the intercanine region, female arches were wider than male ones; however, at the interpremolar and intermolar sections, they were similar in width. Females' maxillary arches were discovered to be bigger antero-posteriorly than those of males. The highest ratio (1.014336113) in the mandibular arch was discovered at the intermolar area, suggesting that males had a larger mandibular posterior arch morphology. At the intercanine area, the breadth of the arch form was greater in males and nearly the same in females at the interpremolar and intermolar regions. Female mandibular arch forms were also discovered to be longer than those of males from the anterior to the posterior.

Conclusions: The male and female arches in the Nepalese population were inferred to be different in size and shape. With references to the landmarks demonstrating such a shift, the EDMA established objectively the presence of square arch forms in Nepali males and tapering arch forms in Nepalese females.

Keywords: Arch form, Euclidean distance matrix analysis, Nepal, sexual dimorphism

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INTRODUCTION

Genes primarily determine the expression of human traits.[1-3] The jaw size, tooth size and arrangement of teeth determine the dental arches. These variables make the arch forms to be invariably determined by genetic changes.[4-11] Several genetic and epigenetic factors bring about changes in the human genome.[12,13] Genetic differences are influenced by the various mixtures of genes that occur by inter-caste marriage, transmigration of population, etcetera.[14,15]

Analysing and categorising the human jaw patterns objectively is difficult. The many analysis techniques employed involve subjective classification of square, 'V', 'U', tapered or ovoid arch forms that may cause reporting ambiguity. Many orthodontists suggest using arch form templates to plan treatment in order to further standardise these procedures.[16] Mathematicians and statisticians have developed numerous techniques in response to the development of morphometrics and the use of coordinate geometry in biological shape research. Fourier transforms and ellipses are frequently used to fit the arch shape to an arc that is represented by a polynomial equation.[17-19]

Ferrario V. (1993)[20] analysed the arch form of 95 subjects (50 males and 45 females) out of a group of 160 healthy Caucasian dental students using Euclidian Distance Matrix Analysis (EDMA). The study was aimed at finding the sexual dimorphisms in dental arch shapes. Women had longer arches in the premolar area, whereas in men, longer and broader arches were noted in the molar region. Differences pointed out in the arch shape were insignificant, but the male arches were found to be larger than those of females. Their study showed that EDMA can significantly demonstrate to the clinician which component of the arch is affecting arch form.

Our study aims to identify the differences in the arch form parameters between genders and between the maxillary and mandibular arches using EDMA, as previously employed by Ferrario.[20]

The adopted null hypothesis was that there would not be a discernible difference between the male and female maxillary and mandibular arches in the Nepalese population's Euclidean distances.

MATERIALS AND METHODS

The study was designed as a pilot study with a three-month patient recruitment goal. Because Nepal's population lacked comparable studies, sample size calculations were not feasible. Institutional ethics committee permission was acquired prior to the study's execution (Ref Number 21031, Sept 2021). Ninety-six participants from the faculty of dentistry at Tribhuvan University in Kathmandu, Nepal, were included in the study. After receiving informed consent, the study recruited individuals in the 18–25 age range. Box numbers were used to ensure the confidentiality of patient identification.

The inclusion criteria for the study were the presence of permanent teeth from the central incisor to the second molar in all quadrants and the absence of crown restorations or previous orthodontic treatment. They were not eligible if they had ever had their teeth extracted or undergone any procedure that altered the contact points. Then, 96 individuals (35 men and 61 women) with all 28 teeth (excluding third molars) had their impressions taken using light and heavy body elastomeric impression materials. Upper and lower casts were then prepared using dental stones taking care to avoid porosities.

Data acquisition

The data acquisition process involved photographing the cast and marking the landmarks (using TPS dig and TPS util software). Standardised pictures were shot with a Canon EOS 700D camera (Canon Inc., Japan) in macro mode. Each cast model was positioned in the centre of the lens field of focus, with a scale put next to it (at the level of the occlusal surface). The occlusal surface of all the teeth was captured in a sharp shot using an intermediate-value diaphragm. According to Wood and Abbot's[21] recommendations, the cementoenamel junction of the maxillary teeth was positioned parallel to the camera lens and perpendicular to the optical axis. The images were stored in *.tiff format for uploading to the TPSdig software for landmark marking.

Thirteen landmarks corresponding to the most facial portions of the proximal contact areas were marked on the maxillary and mandibular casts, using TPS dig and TPS util [Figure 1].

Statistical procedures

Thirteen landmark coordinates were taken in x_i, y_i format and transferred to Microsoft Excel®. The number of Euclidean distances is derived by the formula

$$n \times ((n - 1) \div 2)$$

where n = number of landmarks (i.e., thirteen landmarks) which leads to possibility of 78 Euclidean distances.

$$13 \times ((13 - 1) \div 2) = 78$$

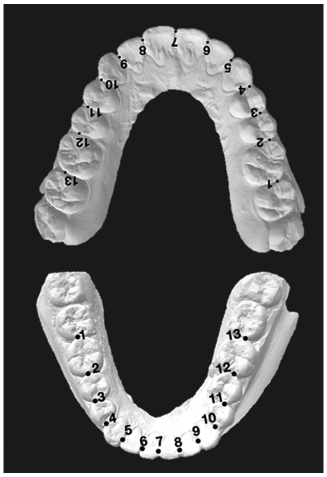

Figure 1: Points digitised represent the most facial portions of 13 proximal contact areas on the maxillary and mandibular casts

Seventy-eight Euclidean distances were calculated from the 13 landmarks, using the formula:

$$\sqrt{[[(x_2 - x_1)]^2 - [(y_2 - y_1)]^2]}$$

Microsoft Excel Analysis ToolPak was used to derive the mean distances for each of the seventy-eight Euclidean distances of the maxillary and mandibular arches.

Following this, the male-to-female ratio was calculated for each Euclidean distance, and then the ratios were arranged in ascending order to analyse arch form parameters in the Nepalese population.

An independent *t*-test was performed, using SPSS 20.0 (IBM Chicago), to assess any significant differences between sexes.

RESULTS

To the selected male and female maxillary and mandibular casts, comprising 13 landmarks each, EDMA was applied which produced 78 ratios among like distances. The numerator consisted of linear distances from the male sample, whereas in the denominator female distances appeared. A numerical value greater than one (i.e., ratio >1) was suggestive of larger arches of males than that of a female and vice versa if the ratio was less than one (i.e., ratio <1). A ratio equal to one suggested male and female arch forms to be similar.

Table 1 depicts the ratio calculated for the maxillary arch. The maximum ratio found was at the most facial aspect of the proximal contact area between the right and left lateral incisor and canine (5-9), i.e., intercanine region, suggestive of wider anterior arch form in males in the canine region. The minimum ratio was at the left first molar region (1-2), implying that the first molar region was longer in females than in males. The calculated median value was 0.989, inferring the Nepalese maxillary female arch form to be comparatively larger than that of the male arch form. The width of the arch form (from left to right, i.e., mesiodistally) was marginally larger in the females in the intercanine/premolar (4-10) region. It was almost equal to that in males at the interpremolar (3-11, 2-12) and intermolar (1-13) regions. Antero-posterior ratio values (1-6, 1-7, 7-13, 8-13) show the female maxillary arch to be longer than the male, indicating a more tapering arch for in females and square arch forms in males.

The calculated ratio between male and female mandibular Euclidean distances is depicted in Table 2. The maximum ratio found [Table 2] was the intermolar distance (1-12), suggestive of wider mandibular posterior arch form in males. The minimum ratio was in the incisor region (7-8) suggestive of narrower incisors arch form seen in males. The calculated median value was 0.988, inferring the Nepalese female arch form to be comparatively larger than that of males. The width of the arch form (from left to right or mesiodistally) was skewed to be larger in the males in the intercanine (4-10) region. It was almost equal to that in females in the interpremolar (3-11, 2-12) and intermolar (1-13) regions. Antero-posterior ratio values (1-6, 1-7, 7-13, 8-13) show the female mandibular arch form to be longer than the male, indicative of a long tapered arch from in females.

To assess the differences in Euclidean distances between males and females, an independent *t*-test was conducted. It demonstrated that there were no appreciable differences between males and females in the linear measurements [Table 3]. The lack of statistically significant variations in the linear measurements between the sexes suggests that there are no differences in the functional area. However, the form factor as displayed by EDMA demonstrates the dimorphism of the arch's shape objectively.

DISCUSSION

The primary motivation for conducting this study was to investigate the never-explored differences in dental arch form parameters between genders in the Nepalese population. Dental arch morphology plays a crucial role in orthodontics and aesthetic dentistry, as it directly influences treatment planning and outcomes.[22-24] Arch

Table 1: Form difference matrix, comparing male maxillary arches with that of females, sorted fro#m lowest to highest

S No.	Landmark	Ratio (Male/Female)	S No.	Landmark	Ratio (Male/Female)	S No.	Landmark	Ratio (Male/Female)
1	1-2	0.958281814	27	3-8	0.983576758	53	1-10	0.995848963
2	3-4	0.961668893	28	3-6	0.983982769	54	4-5	0.996043946
3	1-3	0.965997116	29	6-13	0.984503096	55	3-10	0.998269714
4	10-11	0.966560823	30	4-8	0.985299509	56	4-10	0.998538593
5	12-13	0.968427983	31	2-8	0.985665989	57	4-11	0.998947498
6	11-13	0.968678974	32	2-6	0.985675339	58	3-13	0.999292313
7	2-3	0.969605726	33	3-5	0.986850979	59	5-11	0.999826007
8	9-11	0.969674288	34	2-5	0.987416993	60	7-8	0.999862524
9	1-4	0.969685757	35	7-12	0.988173053	61	3-11	1.000238827
10	9-10	0.969872795	36	6-7	0.988337828	62	6-9	1.000297719
11	10-13	0.969965042	37	4-6	0.988587739	63	5-12	1.000490462
12	11-12	0.97085094	38	5-8	0.988761034	64	2-10	1.000591165
13	9-13	0.970861733	39	6-11	0.988847075	65	1-11	1.000632852
14	8-13	0.971081108	40	3-7	0.9889721	66	5-10	1.000712174
15	10-12	0.971789434	41	7-11	0.989007485	67	4-12	1.000776919
16	9-12	0.972153022	42	6-12	0.989435285	68	3-9	1.001221121
17	8-11	0.974100183	43	2-7	0.989805098	69	2-9	1.001837367
18	8-12	0.974298537	44	6-10	0.990232823	70	3-12	1.003357627
19	8-10	0.977322193	45	5-6	0.99196789	71	2-11	1.003685731
20	1-5	0.977976127	46	4-7	0.992003263	72	4-9	1.00372085
21	1-6	0.978182791	47	8-9	0.992911033	73	2-13	1.005006053
22	2-4	0.978335843	48	7-10	0.992915668	74	1-12	1.006762578
23	6-8	0.979758795	49	5-7	0.994217026	75	1-13	1.007481798
24	1-8	0.980267883	50	5-13	0.994546132	76	2-12	1.007843202
25	7-13	0.982779487	51	1-9	0.994965584	77	7-9	1.008000124
26	1-7	0.982888051	52	4-13	0.995526016	78	5-9	1.008179001

Table 2: Form difference matrix, comparing male mandibular arches with that of females, sorted from lowest to highest

S No.	Landmark	Ratio (Male/Female)	S No.	Landmark	Ratio (Male/Female)	S No.	Landmark	Ratio (Male/Female)
1	7-8	0.933346985	27	5-13	0.979240459	53	3-6	0.993987466
2	11-12	0.95094172	28	7-10	0.980259174	54	4-13	0.994149164
3	10-12	0.961685777	29	5-12	0.981175746	55	6-7	0.995101066
4	9-12	0.963235265	30	1-4	0.982238422	56	2-9	0.995307479
5	6-8	0.963969066	31	5-11	0.982615008	57	3-9	0.996888361
6	7-9	0.966587693	32	5-7	0.983294728	58	3-5	0.996986463
7	5-8	0.967016616	33	1-3	0.984699841	59	4-9	0.997104175
8	8-12	0.967080025	34	6-10	0.984886061	60	3-7	0.998415053
9	9-13	0.968818773	35	5-6	0.985485156	61	4-12	1.000742567
10	7-12	0.969512648	36	1-6	0.986311366	62	3-13	1.001792678
11	8-13	0.969767579	37	12-13	0.986315929	63	4-11	1.003010463
12	9-11	0.970961475	38	2-6	0.987027508	64	4-7	1.005208091
13	10-13	0.971091164	39	1-8	0.987651283	65	4-6	1.008005533
14	7-13	0.971297765	40	2-5	0.988406668	66	2-13	1.008256112
15	2-3	0.971338817	41	1-5	0.988734884	67	3-11	1.008402457
16	6-9	0.971450634	42	2-8	0.988954621	68	1-11	1.008502906
17	11-13	0.972230299	43	9-10	0.989626121	69	1-10	1.00861488
18	7-11	0.97268177	44	5-10	0.990195178	70	3-12	1.008733912
19	8-11	0.972705079	45	1-7	0.990678521	71	2-11	1.010556951
20	6-13	0.972716298	46	3-8	0.991649784	72	1-13	1.011258944
21	6-12	0.972838269	47	1-9	0.992902903	73	4-10	1.011626401
22	2-4	0.974374847	48	8-10	0.992906679	74	4-5	1.01220155
23	10-11	0.974685924	49	2-7	0.992925411	75	2-10	1.012932983
24	6-11	0.975371544	50	8-9	0.993133531	76	2-12	1.013833972
25	5-9	0.976241952	51	1-2	0.993137568	77	3-10	1.013838268
26	3-4	0.978524317	52	4-8	0.993336899	78	1-12	1.014336113

form also has practical applications in the field of forensic odontology. The patterns as they are genetically determined may be used to evaluate geographic variation, ethnicity and sexual dimorphism. Further the patterns can be used for comparative dental evaluation, treatment planning and trauma analysis.[25-29] Understanding the variations in arch form between males and females is essential for clinicians and researchers in Nepal. Additionally, this study contributes to the broader field of dental anthropology and genetics by exploring how genetic and environmental

Table 3: Independent *t*-test to compare the male and female Euclidean distances

Land-mark	Mandibular arch			Maxillary arch		
	Male	Female	*t* (*P*)	Male	Female	*t* (*P*)
1-2	305.04±68.07	307.15±58.22	-0.16 (0.87)	262.5±55.08	273.93±65.66	-0.87 (0.39)
1-3	495.32±112.62	503.02±100.66	-0.35 (0.73)	434.8±91.82	450.1±109.17	-0.7 (0.49)
1-4	687.96±158.42	700.41±139.49	-0.4 (0.69)	614.79±129.48	634.01±150.19	-0.63 (0.53)
1-5	866.82±200.92	876.7±175.79	-0.25 (0.8)	809.4±168.38	827.63±183.75	-0.48 (0.63)
1-6	993.49±227.15	1007.28±199.88	-0.31 (0.76)	971.51±205.19	993.17±211.47	-0.49 (0.63)
1-7	1098.17±249.65	1108.5±221.65	-0.21 (0.83)	1142.42±246.17	1162.3±260.06	-0.37 (0.71)
1-8	1160.92±260.41	1175.43±224.65	-0.29 (0.77)	1234.32±261.14	1259.17±259.48	-0.45 (0.65)
1-9	1234.64±280.16	1243.47±234.64	-0.17 (0.87)	1295.96±267.37	1302.51±263.78	-0.12 (0.91)
1-10	1262.5±284.13	1251.72±226.81	0.2 (0.84)	1303.71±271.63	1309.14±263.12	-0.1 (0.92)
1-11	1268.55±281.59	1257.85±228.17	0.2 (0.84)	1316.78±279.05	1315.95±262.11	0.01 (0.99)
1-12	1290.01±285.24	1271.77±228.47	0.34 (0.73)	1345.44±286.26	1336.4±267.32	0.16 (0.88)
1-13	1352.01±293.64	1336.95±245	0.27 (0.79)	1386.61±293.83	1376.31±275.77	0.17 (0.86)
2-3	191.27±46.87	196.92±45.67	-0.58 (0.57)	174.18±38.92	179.64±43.9	-0.61 (0.54)
2-4	385.32±92.86	395.45±83.6	-0.55 (0.58)	354.88±77.15	362.74±87.3	-0.44 (0.66)
2-5	567.63±136.09	574.29±120.61	-0.25 (0.8)	552.24±116.62	559.28±122.7	-0.28 (0.78)
2-6	703.65±166.37	712.9±147.9	-0.28 (0.78)	721.51±155.75	732±152.98	-0.32 (0.75)
2-7	819.23±192.25	825.07±169.69	-0.15 (0.88)	905.43±199.59	914.75±200.71	-0.22 (0.83)
2-8	898.42±207.31	908.45±177.76	-0.25 (0.8)	1021.91±221.32	1036.77±206.39	-0.33 (0.74)
2-9	993.86±231.72	998.55±190.28	-0.11 (0.92)	1108.07±231.65	1106.04±215.75	0.04 (0.97)
2-10	1054.04±244.18	1040.58±190.32	0.3 (0.77)	1146.89±242.99	1146.21±222.94	0.01 (0.99)
2-11	1098.69±252.12	1087.21±198.34	0.25 (0.81)	1191.9±256.08	1187.53±230.93	0.09 (0.93)
2-12	1160.81±264.26	1144.97±206.29	0.33 (0.75)	1251.73±268.59	1241.99±245.05	0.18 (0.86)
2-13	1288.93±285.86	1278.37±233.76	0.2 (0.85)	1342.09±284.02	1335.4±264.86	0.12 (0.91)
3-4	195.32±47.48	199.6±41.19	-0.46 (0.64)	181.55±39.63	188.78±43.93	-0.8 (0.42)
3-5	379.7±92.25	380.85±78.85	-0.06 (0.95)	379.74±80.5	384.8±83.77	-0.29 (0.77)
3-6	522.74±124.93	525.9±108.2	-0.13 (0.9)	552.32±121.57	561.31±116.82	-0.36 (0.72)
3-7	646.13±153.71	647.15±130.32	-0.04 (0.97)	744±166.66	752.3±163.27	-0.24 (0.81)
3-8	737.99±171.77	744.21±143.47	-0.19 (0.85)	877.21±194.76	891.86±173.88	-0.38 (0.7)
3-9	848.8±198.62	851.45±159.14	-0.07 (0.94)	980.46±207.24	979.26±186.86	0.03 (0.98)
3-10	933.31±217.57	920.57±166.31	0.32 (0.75)	1041.84±223.95	1043.64±198.07	-0.04 (0.97)
3-11	1006.19±232.58	997.8±179.23	0.2 (0.84)	1109.44±241.09	1109.17±214.36	0.01 (1)
3-12	1096.04±250.23	1086.55±193.04	0.21 (0.84)	1190.45±256.95	1186.46±232.76	0.08 (0.94)
3-13	1265.4±281.11	1263.14±228.73	0.04 (0.97)	1313.07±278.03	1314±260.23	-0.02 (0.99)
4-5	188.76±48.4	186.48±43.63	0.24 (0.81)	200.84±45.7	201.64±50.96	-0.08 (0.94)
4-6	342.38±82.29	339.67±75.62	0.16 (0.87)	380.74±86.65	385.14±83.34	-0.25 (0.81)
4-7	475.17±114.87	472.71±99.84	0.11 (0.91)	582.79±134.66	587.49±126.71	-0.17 (0.86)
4-8	583.14±136.49	587.05±118.15	-0.15 (0.88)	739.57±169.3	750.6±144.88	-0.34 (0.74)
4-9	712.2±166.91	714.27±138.48	-0.07 (0.95)	864.22±185.74	861.01±162.6	0.09 (0.93)
4-10	825±192.02	815.51±152.6	0.27 (0.79)	953.44±207.55	954.83±181.94	-0.03 (0.97)
4-11	929.39±213.81	926.6±171.3	0.07 (0.94)	1046.97±228.47	1048.07±202.67	-0.02 (0.98)
4-12	1047.69±237.84	1046.91±190.53	0.02 (0.99)	1150.56±248.37	1149.67±228.11	0.02 (0.99)
4-13	1256.54±278.92	1263.94±233.48	-0.14 (0.89)	1305.98±275.89	1311.85±263.04	-0.1 (0.92)
5-6	168.03±47.04	170.51±40.98	-0.27 (0.79)	191.44±45.99	192.99±43.36	-0.16 (0.87)
5-7	306.49±81.35	311.7±63.77	-0.35 (0.73)	402.54±94.54	404.88±89.3	-0.12 (0.9)
5-8	429.7±106	444.36±86.84	-0.73 (0.47)	586.7±136.37	593.37±116.8	-0.25 (0.8)
5-9	575.63±140.61	589.64±110.32	-0.54 (0.59)	735.1±159.21	729.14±140.93	0.19 (0.85)
5'10	714.99±170.19	722.07±131.97	-0.23 (0.82)	855.88±183.9	855.27±164.84	0.02 (0.99)
5-11	848.25±199.99	863.26±156.85	-0.41 (0.69)	976.88±210.45	977.05±190.87	0 (1)
5-12	991.16±230.18	1010.18±182.74	-0.45 (0.66)	1103.17±235.66	1102.63±220.91	0.01 (0.99)
5-13	1233.14±279.44	1259.28±233.35	-0.49 (0.62)	1291.32±271.85	1298.4±262.17	-0.13 (0.9)
6-7	150.21±43.4	150.95±33.91	-0.09 (0.93)	223.28±52.43	225.91±52.9	-0.24 (0.81)
6-8	277.43±74.71	287.8±61.49	-0.74 (0.46)	422.28±110.31	431±85.49	-0.43 (0.67)
6-9	432.01±106.81	444.7±86	-0.64 (0.53)	589.32±130.99	589.15±110.4	0.01 (0.99)
6-10	587.67±141.49	596.69±112.62	-0.34 (0.73)	734.56±162.8	741.8±140.11	-0.23 (0.82)
6-11	739.53±176.07	758.2±139.49	-0.57 (0.57)	876.76±193.9	886.65±169.68	-0.26 (0.79)
6-12	898.42±208.85	923.51±166.65	-0.65 (0.52)	1020.23±222.24	1031.12±201.73	-0.25 (0.81)
6-13	1162.32±261.61	1194.93±219.25	-0.65 (0.52)	1234.13±263.46	1253.56±247.65	-0.36 (0.72)
7-8	141.29±36.97	151.38±35.29	-1.33 (0.19)	230.55±60.52	230.59±59.63	0 (1)
7-9	299.86±73.51	310.23±62.6	-0.73 (0.47)	410.16±93.13	406.91±91.69	0.17 (0.87)
7-10	469.26±113.98	478.71±94.26	-0.44 (0.66)	582.95±129.49	587.11±129.68	-0.15 (0.88)
7-11	637.3±153.67	655.2±125.21	-0.62 (0.54)	746.47±166.34	754.77±167.02	-0.23 (0.82)
7-12	808.67±187.83	834.1±156.71	-0.71 (0.48)	906.09±199.86	916.93±205.58	-0.25 (0.8)
7-13	1089.04±245.78	1121.22±213.06	-0.67 (0.5)	1144.57±248.68	1164.63±258.93	-0.37 (0.71)
8-9	170.99±44.58	172.17±38.72	-0.14 (0.89)	189.82±42.63	191.17±45.01	-0.14 (0.89)

Contd...

Table 3: Contd...

Land-mark	Mandibular arch			Maxillary arch		
	Male	Female	*t* (*P*)	Male	Female	*t* (*P*)
8-10	342.64±94.69	345.09±70.27	-0.14 (0.89)	373.42±81.95	382.08±87.81	-0.48 (0.63)
8-11	517.5±138.01	532.02±103.26	-0.59 (0.56)	547.01±121.21	561.56±126.14	-0.55 (0.58)
8-12	695.61±171.56	719.29±135.87	-0.75 (0.46)	714.11±155.65	732.95±165.11	-0.55 (0.58)
8-13	985.49±229.92	1016.22±191.76	-0.7 (0.48)	966.59±206.56	995.37±219.1	-0.63 (0.53)
9-10	190.62±53.38	192.62±40.98	-0.21 (0.84)	196.32±44.83	202.42±45.37	-0.64 (0.53)
9-11	376.52±100.45	387.78±76.62	-0.62 (0.54)	375.83±83.14	387.59±85.49	-0.65 (0.51)
9-12	561.46±138.62	582.89±113.35	-0.82 (0.41)	547.07±118.59	562.74±127.23	-0.6 (0.55)
9-13	860.73±202.11	888.44±171.8	-0.71 (0.48)	807.8±171.31	832.04±183.67	-0.64 (0.53)
10-11	194.42±48.44	199.47±39.34	-0.56 (0.58)	181.91±41.36	188.2±44.78	-0.68 (0.5)
10-12	381.44±90.31	396.64±76.08	-0.88 (0.38)	353.74±78.77	364.01±87.09	-0.58 (0.57)
10-13	683.91±157.9	704.27±133.72	-0.67 (0.5)	617.12±133.02	636.23±144.57	-0.64 (0.52)
11-12	189.25±44.01	199.01±39.52	-1.12 (0.27)	172.41±38.53	177.59±44.59	-0.57 (0.57)
11-13	493.54±111.97	507.63±97.63	-0.65 (0.52)	437.24±93.53	451.37±102.49	-0.67 (0.5)
12-13	305.69±69.67	309.93±60.21	-0.31 (0.76)	266.83±57.07	275.53±60.78	-0.69 (0.49)

factors may influence dental arch morphology in a specific population.

The chosen methodology for this study involved EDMA,[30] which was previously employed by Ferrario (1993)[20] in a similar study to assess dental arch pattern variations. EDMA is a robust approach for quantifying and comparing differences in dental arch shapes based on landmark coordinates.[31-34] This method provides a systematic and objective way to analyse dental arch morphology. While alternative methods exist, such as geometric morphometrics[35,36] or three-dimensional imaging techniques,[37,38] EDMA offers a straightforward and widely accepted approach[31-34] for the specific research questions addressed in this study.

Literature reveals significant differences in the male and female facial form and size.[39-44] Henceforth, sexual dimorphism in the arch form was expected. Increase in arch width during growth occurs more in males which results in broader male arches than that in females.[45] The results of this study revealed several interesting findings. In the maxillary arch, the male-to-female ratio was highest in the inter-incisal region (landmark 5-9), indicating the most significant arch form variation in the anterior portion. This finding aligns with previous research[46-50] that suggests greater sexual dimorphism in anterior dental arch morphology. Conversely, the lowest ratio was found in the left first molar region (landmark 1-2), indicating lesser variation in the posterior.

In the mandibular arch, the highest ratio was observed in the intermolar region (landmark 1-12), suggesting a wider posterior arch form in males. Again, this finding is in line with previous research[46-50] indicating sexual dimorphism in the posterior arch. The lowest ratio was found in the incisor region (landmark 7-8), indicating less variation in the arrangement of mandibular anterior region.

Comparing these results to previous studies, the findings are consistent with the general trend of sexual dimorphism in dental arch morphology. However, the specific ratios and regions showing the most significant differences may vary between populations due to genetic and environmental factors.[16, 22, 51-55] These variations emphasise the importance of conducting population-specific studies, as demonstrated in this research.

This study contributes valuable information about dental arch form variation in the Nepalese population, which has not been extensively studied previously. The findings highlight the presence of sexual dimorphism in both maxillary and mandibular arches, with specific regions showing more significant differences. In our study, female maxillary and mandibular arches length antero-posteriorly was longer than male arches in the Nepal population. Prasad M *et al.* (2013) evaluated the arch patterns in the South Indian population and found significantly larger intercanine, interpremolar and intermolar widths in males than in females.[46] Similar results were shown in Caucasians,[47] Ugandans,[48] Jordanians[49] and Italians.[50]

Furthermore, the study emphasises the importance of considering population-specific factors when assessing dental arch form, as the observed variations may not necessarily be applicable to other populations. Clinicians and researchers working with Nepalese patients can benefit from this knowledge when planning orthodontic or prosthodontic treatments.

However, it is essential to acknowledge the limitations of this study, including the relatively small sample size and the use of two-dimensional measurements. Future research could incorporate larger sample sizes and three-dimensional imaging techniques for a more comprehensive analysis.

This study opens the door for further research in the field of dental arch morphology in Nepal. Future studies could explore the genetic and environmental factors that contribute to these observed variations. Additionally, examining the impact of these variations on orthodontic treatment outcomes and prosthodontic interventions could provide valuable insights for clinicians. Furthermore, comparative studies between different ethnic groups within Nepal or neighbouring regions could shed light on the broader genetic and anthropological context of dental arch morphology in South Asia.

In conclusion, this study addresses an important aspect of dental anthropology and orthodontics in the Nepalese population. It underscores the significance of population-specific research in understanding dental arch form and its implications for clinical practice.

CONCLUSION

The form and shape of the arch vary depending on the population. Therefore, it is crucial to analyse the different arch forms in a population-specific manner. Our study found that the female arch form was larger than the male arch form in the Nepalese population. Epigenetics, habits and genetic factors all play a role in defining the shape of the arch. To further elaborate, the arch form is a critical aspect of dental health and aesthetics. Understanding the variations in arch form across different populations can aid in the development of more effective orthodontic treatments. Additionally, the influence of several factors on arch form highlights the importance of personalised treatment plans.

Key message

The EDMA demonstrated objectively the presence of square arch forms in Nepali males and tapering arch forms in Nepali females with references to the locations confirming such shift.

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Conflicts of interest

There are no conflicts of interest.

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