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Original Research Article

Dental Arch Dimensions in Normal and Malocclusion Yemeni Samples

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Abstract

Objectives: The objectives of this study were to identify dental arch widths and lengths of the Yemeni population, identifying any possible sex differences and comparing arch widths and lengths between normal and malocclusion groups. ***Subjects and Methods:*** In this investigation, study models of 176 subjects were taken (82 Male, 94 Female) with a mean age of 21.9± 2.8 years. The subjects displayed different types of malocclusions (94 Angle Class I, 37 Class II division1, 36 Class II division 2, and 9 Class III). ***Results:*** The maxillary and mandibular dental arch lengths of the male subjects were significantly longer than those of the females. Among the males, maxillary arch widths were significantly larger than the females', with the exception of the intercanine width. There were no statistically significant sex differences in the mandibular intercanine and first premolar interarch widths found in this study. Male subjects showed significantly wider mandibular interarch widths than females, and this was true for all measured points at second premolar and first molar arch widths. No significant differences were detected between the normal and malocclusion groups in dental arch lengths and widths. ***Conclusion:*** There is a tendency for Yemeni females to exhibit shorter dental arch lengths and narrower maxillary and mandibular arch widths than Yemeni males. With regard to dental arch lengths and widths across normal and malocclusion groups, no significant differences were identified.

Keywords: Arch length, Arch width, Yemenis**.**

INTRODUCTION

Determination of the shape and size of dental arches is of great importance, as these have considerable implications in the diagnosis, treatment planning and final outcomes of orthodontic results, as well as its stability. Additionally, people from different ethnic and racial groups present varying morphological conditions; these racial variations should be considered during diagnosis and orthodontic treatment planning rather than approaching all cases in the same way[1,2]. Burris and Harris [1] investigated the arch form and size in a sample group of black and white Americans. Their results revealed that the arch size is larger in American blacks than it is in whites. As a result, they concluded that ethnic differences should be carefully considered during treatment.

Diwan and Elahi [2] studied the intermolar and intercanine widths in Philipinos and compared them to people from the Middle East (Egyptians and Saudis). The Philipino group showed narrower intermolar width than Egyptians and larger intercanine width than Saudis.

Al-Tamimi and Hashim [3] studied gender variations among Class I occlusion of Saudi subjects. Their research revealed that males had significantly greater maxillary and mandibular intercanine and intermolar widths than females. Al‐Zubair [4,5] investigated Yemeni dental arch dimensions of normal dentoskeletal samples. They reported gender variations in which male subjects had greater measurements than females.

In contrast, Nojima *et al*. [6] compared the dental arches between Caucasian and Japanese individuals and failed to find sexual dimorphism. They concluded that establishing gender groups in ethnic populations is not necessary.

Namely, only two studies have examined the arch configuration of Yemenis [4,5]. The research was conducted on normal occlusion samples. Still, there is a lack of relevant orthodontic information that could be of use to clinical practice in Yemen. For this reason, the current study was designed to determine the mean length and width of dental arches in the Yemeni population. It also aimed to identify any possible sex differences, as well as comparing the arch lengths and widths between different types of malocclusions.

Subjects and Methods

The present research was endorsed by the College of Dentistry's Ethical Committee, Taibah University. The material of this study involved taking study models of 176 subjects (*82* Male, *94* Female), with a mean age of 19.11 ± 3.01 years old (range 13 – 25 years). The subjects displayed different types of malocclusions (94 Angle Class I, 37 Class II division1, 36 Class II division 2, and 9 Class III). They were recruited by university students at Ibb University, as well as from the author’s private dental clinic in Ibb city, Yemen. Accidental sampling was chosen as the sampling technique. The selection criteria were as follows: Yemeni citizen; all study casts were of good quality; all teeth fully erupted; sound teeth; no preceding or current orthodontic treatment; normal tooth morphology, and no posterior crossbite.

Arch length measurements

The arch was divided into 6 segments and each segment was measured as follows:

- Posterior segment: measured from the first molar mesial contact to the distal contacts of the canines.
- Middle segment: the length around the canine.
- Anterior segments: measured from the mesial contact of the canines to the midline (point between the central incisors).
- Sum of all segments on both sides represents the dental arch length.

Arch width measurements: (Figure 1)

The arch width was measured as described by Al-Khateeb and Abu Alhaija, [7]. The following measurements were adopted:

- Intercanine width: the distance from cusp tips of the right and left canines
- Interpremolar width (first and second premolars): the distance between the buccal cusp, central fossa, and lingual cusp on the right side to its contralateral on the left side.
- Intermolar width: the distance between the mesiobuccal cusps, central fossa, and the mesiolingual cusp of the first molar on the right side to its contralateral on the left side.

The points identified on the casts were marked with a sharp pencil (0.5-mm tip width). All casts were then scanned and the distance between these marked points were measured using Image J 1.43u software (National Institutes of Health, Bethesda, MD). Magnification errors were avoided by using a millimetric ruler that was fixed and scanned together with the casts. This task was carried out by a single investigator.

Methodological Error

To evaluate the method's error, 30 casts were selected at random and measured twice. The second measurement was taken after a one-month interval. The results were compared using a paired t-test. No significant variations were discovered.

Statistical Methods

A Student’s t-test was used to make comparisons between the sexes, as well as between the Class I malocclusion group (designated as the normal occlusion group) and the malocclusion groups. SPSS analysis software (version 17, SPSS, IBM Corporation, USA) was selected to assist in the statistical analyses. The significance level was set at $p < 0.05$.

RESULTS

Table 1 exhibits sample distribution according to sex and type of malocclusion. 53.4 % of the subjects had class I malocclusion, while 46.5 % of the sample exhibited malocclusion (21 % Class II division1, 20.4 % Class II division 2, and 5.1 % Class III). Female subjects were dominated in all groups other than Class II division 2.

Table 2 presents the mean and standard deviations of the arch length for the total sample, as well as for the male and female groups.

The mean dental arch length in Yemenis was found to be 73.3±4.4 mm in the maxilla, and 62.8±3.7 mm in the mandible. Male subjects had significantly greater upper and lower dental arch lengths than females ($p < 0.001$), with a mean difference of 2.29 mm in the maxilla and 1.58 mm in the mandible.

A comparison of the dental arch length across the normal and malocclusion groups is displayed in Table 3. There were no statistically significant differences between the groups.

Table 4 outlines the dental arch width for the total sample. It also compares the dental arch width measurements of each sex. The results show that the maxillary arch width of males was significantly greater than that of the female subjects. This was true for all of the measurements ($p < 0.001$) apart from the intercanine width.

As for the mandibular arch widths, no statistically significant gender variations in the intercanine and first premolar interarch widths were found. Male subjects exhibited interarch widths that were significantly wider than the females’ in all measured points at second premolar and first molar arch widths ($p < 0.001$).

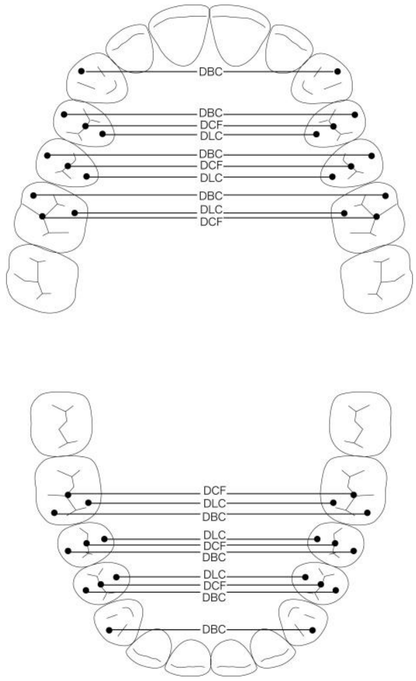

Figure- 1: Maxillary and Mandibular dental arch measurements

DBC: distance measured from the buccal cusp tips on the right to the buccal cusp tips on the left
DCF: distance measured from the central fossa on the right to central fossa on the left
DLC: distance measured from the lingual cusp on the right to the lingual cusp on the left.

A comparison between the normal and malocclusion groups is shown in Table 5. Again, there were no statistically significant variations among the groups.

Table1. Sample Distribution According to Sex and Type of Malocclusion

Malocclusion	Male (n = 82)	Female (n = 94)	Total 176 (%)
Class I	44	50	94 (53.4)
Class II division I	11	26	37 (21.0)
Class II division 2	25	11	36 (20.5)
Class III	2	7	9 (5.1)

n= number of subjects

Table 2. Arch Length for the Total Sample and for Male and Female Groups (mm)

Arch Length	Total (n = 176)				Male (n = 82)		Female (n = 94)		Mean Difference (mm)	p-value
	Mean	SD	Min	Max	Mean	SD	Mean	SD		
Maxillary arch	73.35	4.49	61.74	88.7	74.57	4.06	72.28	4.59	2.29	0.001
Mandibular arch	62.86	3.70	53.09	71.21	63.70	3.78	62.12	3.48	1.58	0.004

n= number of subjects

Table 3. Comparison of Arch Length between Normal and Malocclusion Groups (mm)

Arch Length	Normal (n = 94) *		Malocclusion (n = 82)		Mean Difference (mm)	p-value
	Mean	SD	Mean	SD		
Maxillary arch	73.56	3.92	73.11	5.08	0.44	0.52
Mandibular arch	62.83	3.44	62.89	3.99	0.06	0.92

n= number of subjects, * Class I Malocclusion (designated as Normal occlusion)

Table 4. Dental Arch Widths for the Total Sample and for Male and Female Groups (mm)

Arch	Variable	Total Sample (n = 176)				Male (n = 82)		Female (n = 94)		Mean Difference (mm)	p-value
		Mean	SD	Min	Max	Mean	SD	Mean	SD		
Maxillary arch											
	Intercanine width	32.47	2.71	25.08	39.23	32.89	2.56	32.10	2.79	0.78	0.06
	1st premolar										
	DBC	39.27	2.98	30.07	49.53	40.23	2.52	38.44	3.10	1.79	0.0001
	DCF	34.47	2.80	26.54	43.02	35.41	2.43	33.65	2.84	1.76	0.0001
	DLC	29.66	2.82	22.06	39.05	30.48	2.52	28.94	2.90	1.53	0.0001
	2nd premolar										
	DBC	44.06	3.38	34.05	53.32	45.23	3.16	43.04	3.26	2.19	0.0001
	DCF	39.13	3.22	29.67	47.02	40.36	2.91	38.06	3.10	2.30	0.0001
	DLC	34.48	3.19	25.43	42.17	35.65	2.75	33.47	3.21	2.18	0.0001
	1st molar										
	DBC	49.16	3.61	37.05	58.59	50.50	3.21	47.99	3.55	2.50	0.0001
	DCF	45.60	3.27	34.85	53.04	46.89	2.82	44.48	3.23	2.41	0.0001
	DLC	39.22	3.32	26.83	47.41	40.48	2.84	38.11	3.32	2.37	0.0001
Mandibular arch											
	Intercanine width	24.68	2.28	17.40	34.60	24.70	2.21	24.66	2.35	0.04	0.90
	1st premolar										
	DBC	32.34	2.54	21.22	42.00	32.63	2.33	32.09	2.70	0.54	0.16
	DCF	29.34	2.39	18.49	36.39	29.67	2.29	29.05	2.46	0.62	0.08
	DLC	26.06	2.39	16.43	32.67	26.41	2.33	25.75	2.41	0.66	0.07
	2nd premolar										
	DBC	37.45	3.08	27.88	46.95	38.26	2.68	36.74	3.25	1.52	0.001
	DCF	34.13	2.91	25.31	41.66	34.88	2.63	33.48	3.01	1.39	0.001
	DLC	29.87	3.04	20.55	39.55	30.64	2.78	29.20	3.11	1.44	0.002
	1st molar										
	DBC	42.72	3.21	33.86	51.62	43.73	3.09	41.85	3.06	1.89	0.0001
	DCF	40.69	2.94	33.19	49.19	41.63	2.91	39.88	2.73	1.75	0.0001
	DLC	33.11	2.91	25.01	41.08	34.06	2.65	32.29	2.88	1.77	0.0001

DBC: indicates distance between the buccal cusp on the right side to the buccal cusp on the left side, DCF: indicates distance between the central fossa to central fossa, DLC: indicates the distance between the lingual cusp to the lingual cusp.

Table 5. Descriptive Comparison of the Arch Widths for Normal and Malocclusion Groups (mm)

Arch	Variable	Normal (n = 94) *		Malocclusion (n = 82)		Mean Difference (mm)	p-value
		Mean	SD	Mean	SD		
Maxillary arch							
	Intercanine width	32.63	2.51	32.29	2.93	0.34	0.40
	1st premolar						
	DBC	39.54	2.76	38.96	3.20	0.58	0.20
	DCF	34.69	2.60	34.22	3.00	0.48	0.26
	DLC	29.92	2.51	29.36	3.13	0.57	0.19
	2nd premolar						
	DBC	44.45	3.08	43.62	3.67	0.83	0.10
	DCF	39.44	2.99	38.77	3.44	0.67	0.17
	DLC	34.79	2.94	34.13	3.44	0.66	0.17
	1st molar						
	DBC	49.43	3.64	48.85	3.58	0.58	0.29
	DCF	45.82	3.28	45.35	3.25	0.47	0.34
	DLC	39.40	3.33	39.01	3.31	0.40	0.43
Mandibular arch							
	Intercanine width	24.65	2.00	24.71	2.58	-0.05	0.88
	1st premolar						
	DBC	32.25	2.24	32.44	2.86	-0.19	0.63
	DCF	29.27	2.06	29.41	2.74	-0.14	0.70
	DLC	26.00	2.07	26.13	2.72	-0.13	0.72
	2nd premolar						
	DBC	37.39	2.78	37.51	3.41	-0.12	0.80
	DCF	34.02	2.59	34.26	3.26	-0.24	0.59
	DLC	29.71	2.60	30.05	3.49	-0.34	0.47
	1st molar						
	DBC	42.83	3.16	42.61	3.27	0.22	0.65
	DCF	40.81	2.84	40.57	3.06	0.24	0.59
	DLC	33.27	2.70	32.93	3.14	0.34	0.44

DBC: indicates distance between the buccal cusp on the right side to the buccal cusp on the left side, DCF: indicates distance between the central fossa to central fossa, DLC: indicates the distance between the lingual cusp to the lingual cusp.

*Class I Malocclusion (designated as Normal occlusion)

DISCUSSION

It has been reported that little or no growth changes occur in the intercanine and intermolar widths after the age of 13 in females, and 16 in males [8,9].

For this reason, the present study only focused on a sample with a mean age of 19.1 ± 3.2 and 19.3 ± 3.4 years old for males and females respectively. This measure was taken to minimize the impact of these variables on real measurements of the dental arch.

Due to difficulties in recruiting Class III subjects, Class II and Class III subjects were combined and designated as the malocclusion group. These were then compared with the normal group.

The results of this study revealed that the mean Yemeni maxillary and mandibular dental arch lengths were 73.3 ± 4.4 mm and 62.8 ± 3.7 mm respectively. When comparing these results to those of other Arabian groups, the Yemeni dental arch length is very similar to that of Saudis, as reported by Hashim and Al-Ghamdi [10].

Based on the outcomes of this study, both maxillary and mandibular arch lengths were significantly longer in males than in females ($p < 0.001$). This reflects the results of previous studies undertaken by Burris and Harris, [1] Tamimi and Hashim, [3] Hashim and Al-Ghamdi [10] and Staley *et al*.[11] On the other hand, this finding does not correspond with the results obtained by Hashim and Al-Ghamdi, [12] who failed to identify any significant sexual dimorphism in the dental arch length in a sample of Saudi subjects.

No significant variations were noted when comparing the dental arch length between the normal and malocclusion groups. Similar results were reported by Hashim and Al-Ghamdi, [10] for the Saudi population.

On reviewal of the results, there was no significant gender dimorphism between the male and female groups regarding both the upper and lower intercanine widths. The same finding was reported by Diwan and Elahi [2] and Younes [13] in Saudi and Egyptian samples, and Othman *et al*.[14] for Malaysians. However, this was not true for the results found by Al-Khateeb and Abu Alhaija, 9 in Jordanians, and Sarhan and Diwan [15] in Egyptian and British samples.

The results of this study showed that male subjects had wider maxillary arch widths than female subjects in all of the posterior measurements ($p < 0.001$). Furthermore, male subjects demonstrated significantly wider mandibular dental arch widths than females in all of the posterior arch widths ($p < 0.001$), with the exception of the inter-first premolar arch width. Sexual dimorphism was also found, thus supporting the findings of previous studies conducted by Burris and Harris, [1] British, Hashim and Al-Ghamdi, [10] and Asiry and Hashim [16] for Saudi Arabians.

The outcomes of this study are also in line with those of Al-Khateeb and Abu Alhaija, [7] Asiry and Hashim [16] and Ling and Wong,[17] in that there was a tendency for female subjects to have narrower upper and lower dental arch widths than males at the interpremolar and intermolar regions. At the same time, the current results differ from those reported by Nojima et al [6] and Othman *et al.* [14] who reported no significant differences across racial groups in terms of dental arch dimensions.

Notably, sexual variation in the dental arch widths was more obvious in the maxilla than in the mandible (Table 4) – a result that is consistent with the findings of previous studies focusing on Yemeni samples[4,5].

It was interesting to note a gradual increase in the mean difference between males and females in the upper and lower dental arch widths from the intercanine to the intermolar regions; intercanine widths demonstrated the smallest difference, followed by first premolar and second premolar widths, as well as intermolar widths (Table 4).

The results of this particular study demonstrated that the dental arch widths of Yeminis were narrower than other Arabian groups of Saudis [5] and Jordanians [7]. However, some measurements could not be compared with these studies as they did not use the same measurement reference points.

Another point to note is the gradual increase that was discovered in the dental arch widths from south to north, with Yemenis (south part) showing narrower arch widths, followed by Saudis (middle part) and Jordanians (north part). A possible explanation for this variation between Yemenis and other Arabian groups may be related to function, external influences such as diet, and adaptation to their place of residence. When comparing the dental arch widths between normal and malocclusion groups, no statistically significant differences were observed. This reflects the results obtained by Hashim and Al-Ghamdi [10] and Asiry and Hashim [16] for the Saudi population. On the other hand, this finding differs from that of Staley *et al*. [11] Uysal *et al.* [18] and Buschang *et al*. [19]

CONCLUSIONS

There is a tendency for Yemeni females to exhibit shorter dental arch lengths and narrower maxillary and mandibular arch widths than Yemeni males. With regard to dental arch lengths and widths across normal and malocclusion groups, no significant differences were identified.

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