

# Evaluation of Dental Crowding and Spacing in Relation to Tooth Size and Arch Dimensions in a Sample of Sudanese Adults

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## ABSTRACT

**Aims:** This study aimed to compare tooth size and arch dimensions between normal, crowded, and spaced groups in a Sudanese sample.

**Material and methods:** A sample of 312 university students, were selected and divided into normal, crowded, and spaced groups. Each group included 104 students with equal males to females ratios. Age was ranged from 16 to 26 years. Mesiodistal (MD) tooth width of all teeth (except molars), arch perimeters, and dimension at the level of intercanine, interpremolar, and intermolar were measured for each group. ANOVA and student t-test were performed for the comparison between groups.

**Results:** The MD dimensions of all teeth are greater in crowded arches as compared to the teeth in normal dental arches, except for the width of the maxillary, left second premolar in females, and mandibular left second premolar in male. Spaced arches were presented with significantly smaller MD width in all teeth when compared to normal arches, except for the width of maxillary right second premolar, maxillary left first premolar, mandibular right and left second premolars in female, and maxillary right second premolar in male. Crowded arches exhibit the largest total tooth material followed by normal and spaced dentition. Spaced arches show the widest arch dimension and perimeters followed by normal and crowded dentitions.

**Conclusions:** Both tooth size and arch dimensions contribute to dental crowding and spacing.

**Clinical relevance:** Since the size of the teeth and dental arches affect the space availability of the dentition. These factors should be considered in the initial stages of orthodontic treatment planning to avoid compromised treatment outcomes.

**Keywords:** Arch dimension, Crowded, Spaced, Sudanese, Tooth size.

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## INTRODUCTION

A well-aligned set of teeth improve esthetics and stability. Additionally, a perfect tooth position provides ideal environments for good health and the best care of teeth.<sup>1</sup> Dental arch integrity is a result of coordination between tooth and arch dimensions. Any imbalance between these components can lead to dental crowding and spacing.<sup>2</sup> Dental crowding and spacing are the most common forms of malocclusions;<sup>3,4</sup> they express great esthetic and functional problems in orthodontic patients.<sup>5</sup>

In the previous literature, many investigations<sup>1,6-10</sup> were carried out to examine the extent to which tooth size and arch dimension contribute to dental crowding and spacing. Howe et al.<sup>7</sup> found no significant differences in tooth sizes between the noncrowded and crowded groups, but they found significant differences in arch dimensions between the crowded and the noncrowded groups. Randzic<sup>6</sup> revealed that there were significant correlations between certain arch dimensions and the degree of crowding. There was no significant correlation between cumulative mesiodistal (MD) crown widths and dental crowding when considered in isolation. Golwalkar and Msitry,<sup>11</sup> identified that noncrowded individuals possess larger arch width dimensions and perimeters both in males and females.

Concerning dental spacing, Steigman et al.<sup>12</sup> found that in male patients, intercanine and interpremolar distances were greater only in the maxilla. Mean MD dental width in men did not differ between those with and those without spacings. In contrast, in females, the mean MD tooth width was significantly narrower in spaced dentition and dental arch size was not related to spacing.

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Farauqui et al.<sup>1</sup> found that the MD dimensions of all teeth are smaller in spaced arches as compared to normal dental arches, but only spaced mandibular arches were wider than the normal mandibular arches. Bugaighis et al.<sup>10</sup> reported that there was a trend for smaller tooth widths in spaced dentitions compared to normal ones.

Despite the existence of several studies,<sup>1,6-10</sup> exploring these types of malocclusions, there is still a need for further investigation particularly for different populations, especially because of the contribution of genetic factors in the variation of tooth size and arch dimension in different ethnic groups.<sup>2,13-15</sup> Therefore, the present study was intended to compare tooth size and arch dimensions between normal, crowded, and spaced groups in the Sudanese sample.

## MATERIALS AND METHODS

This cross-sectional study was conducted at Al Neelain University, Khartoum, Sudan. Ethical approval was obtained from the Central Institutional Review Board in Al Neelain University. Before examination and impression taking, informed consent was obtained from students.

A sample of 312 dental casts of Sudanese subjects aged 16 to 26 years was collected. The students were selected according to the following inclusion criteria: (1) subjects with Angle's class I molar relationship bilaterally, (2) all teeth were present and fully erupted from the first right molar to the first left molar, (3) no history of orthodontic treatment, prosthetic tooth replacements or crowns, and (4) no evidence of tooth wear lesions, interproximal caries, restorations or dental anomalies.

The tooth size arch length discrepancy was calculated in each arch as the difference between the sum of MD tooth dimensions and the arch perimeter mesial to the first permanent molars.

The grouping of the sample was done on the basis of this space discrepancy. In this study, arches with a space discrepancy of  $0 \pm 3$  mm were defined as normal, arches with a space discrepancy of more than  $-4$  mm were defined as crowded, and arches with a space discrepancy of more than  $+4$  mm were labeled as spaced arches. A total of 312 casts met the criteria of grouping and they were divided into normal, crowded, and spaced dental arches groups with 104 casts in each group.

For each cast, the following parameters were recorded: (1) MD crown diameters of all permanent teeth, except molars, were recorded; measurements were taken at the greatest distance between the contact points of the proximal surfaces of the dental crown, with the calipers parallel to the occlusal and buccal surfaces,<sup>2</sup> (2) lingual arch dimensions were measured for the canine region, first premolar region, and the first molar region at the cervical region of each distinguished tooth from the midpoint of the lingual surface of the tooth to the corresponding point on it is antimere,<sup>7</sup> (3) arch perimeters were measured with the help of brass wire from the mesial marginal ridge of left to right first permanent molar passing over the premolar and canine regions following the respective curve of occlusion in each arch.<sup>16</sup>

All the measurements were made by one examiner using electronic digital calipers (0–150 mm/6"  $\times$  0.01 JAPAN), which provided a precision reading to the nearest 0.01 mm.

Two weeks after the data collection, 94 dental casts were randomly selected and replicated measurements were made by the same investigator to detect any measurement error. Reliability for cast measurements was found to be satisfactory,<sup>17</sup> as intraclass correlation coefficients ranged from 0.965 to 0.545.

All data were analyzed with SPSS software (version 10.0, SPSS, Chicago, Illinois). Q-Q plot test and histogram showed that the data were normally distributed, and thus, parametric tests were used. Descriptive statistics were performed and reported with means and standard deviations for all variables in all groups. ANOVA and student *t*-test were performed for the comparison between groups. A level of significance ( $p \leq 0.05$ ) was used for statistical tests.

## RESULTS

The mean age of students who participated in this study was  $19.5 \pm 2.2$ .

### Comparison between Crowded and Normal Dentitions

An independent sample *t*-test was used to compare the mean value of the MD size of teeth between the two groups (Table 1). In general, the mean values of the MD tooth width in the crowded male and female were higher than the normal group. In males, a significant difference was found in all teeth ( $p \leq 0.05$ ) except mandibular left second premolar ( $p = 0.086$ ). Females show significant differences in all teeth except maxillary left second premolar ( $p = 0.238$ ).

### Comparison between Spaced and Normal Dentitions

An independent sample *t*-test was used to compare the two groups (Table 2). The mean values of the MD tooth width in the spaced male and female were smaller than the normal group. In males, a significant difference was found in all teeth ( $p \leq 0.05$ ) except maxillary left second premolar ( $p = 0.224$ ), while in female, significant difference was found in all teeth ( $p \leq 0.05$ ) except maxillary left first premolar ( $p = 0.133$ ), maxillary right second premolar ( $p = 0.512$ ), mandibular right second premolar ( $p = 0.213$ ), and mandibular left second premolar ( $p = 0.161$ ).

### Comparison between the Three Groups using ANOVA

#### *TTM (Total Tooth Material)*

The crowded group shows the highest value in TTM followed by the normal group and lastly the spaced group (Table 3). In the maxilla, the male mean value was 74.10, 77.61, and 71.74 for normal, crowded, and spaced dentitions, respectively. While the female mean value was 71.82, 76.49, and 69.20 for normal, crowded, and spaced dentitions, respectively. In the mandible, the male mean value was 64.84, 67.73, and 62.18 for normal, crowded, and spaced dentitions, respectively.

While the female mean value was 62.90, 66.79, and 59.50 for normal, crowded, and spaced dentitions, respectively.

#### *Arch Perimeter*

The spaced group shows the highest value in the arch perimeter, followed by the normal group and lastly the crowded group (Table 3).

In the maxilla, the male mean value of arch perimeter was 75.51, 71.71, and 79.11 for normal, crowded, and spaced dentitions, respectively. While the female mean value of arch perimeter was 72.33, 68.93, and 75.51, normal, crowded, and spaced dentitions, respectively. In the mandible, the male mean value of arch perimeter was 63.28, 60.96, and 67.89 for normal, crowded and, spaced dentitions, respectively. While the female mean value of arch perimeter was 61.05, 58.50, and 64.56 for normal, crowded, and spaced dentitions, respectively. ANOVA revealed highly statistically significant discrepancies between the compared mean values in the three examined groups in both maxilla and mandible ( $p \leq 0.001$ ).

#### *Arch Dimensions*

Arch dimensions were greater in the spaced group followed by the normal and lastly crowded group. Figure 1 represents statistical female averages for the normal, crowded, and spaced groups. Spaced group shows the widest value in all level of arch dimension both in maxilla and mandible (Table 4).

#### *Inter Canine Width*

In the maxilla, the male mean value was 27.10, 25.59, and 28.10 for normal, crowded, and spaced dentitions, respectively. While the female mean value was 25.45, 24.77, and 26.53 for normal, crowded, and spaced dentitions, respectively. In the mandible, the male mean

Relationship of Crowding and Spacing to Tooth and Arch Dimensions

**Table 1:** Comparison of MD dimensions of teeth between crowded and normal

	<i>Gender</i>											
	<i>Male</i>						<i>Female</i>					
	<i>Group</i>			<i>Group</i>			<i>Group</i>			<i>Group</i>		
	<i>Normal</i>		<i>Crowded</i>		<i>t</i>	<i>"p" value</i>	<i>Normal</i>		<i>Crowded</i>		<i>t</i>	<i>"p" value</i>
<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>	<i>Mean</i>			<i>SD</i>	<i>Mean</i>	<i>SD</i>			
UR5	6.64	0.37	6.85	0.50	-2.456	0.016	6.45	0.42	6.88	0.45	-5.056	<0.001
UR4	7.16	0.48	7.42	0.49	-2.790	0.006	6.92	0.36	7.40	0.46	-5.974	<0.001
UR3	7.90	0.48	8.14	0.53	-2.391	0.019	7.48	0.45	7.88	0.53	-4.189	<0.001
UR2	6.88	0.53	7.24	0.52	3.425	0.001	6.77	0.61	7.26	0.57	-4.273	<0.001
UR1	8.69	0.49	9.18	0.70	-4.094	<0.001	8.49	0.49	9.01	0.61	-4.799	<0.001
UL1	8.69	0.53	9.11	0.79	-3.216	0.002	8.39	0.65	8.95	0.68	-4.253	<0.001
UL2	6.82	0.48	7.22	0.60	-3.730	<0.001	6.64	0.50	7.23	0.61	-5.333	<0.001
UL3	7.90	0.44	8.12	0.55	-2.314	0.023	7.41	0.46	7.80	0.54	-3.936	<0.001
UL4	7.08	0.47	7.38	0.47	-3.226	0.002	6.88	0.38	7.38	0.48	-5.819	<0.001
UL5	6.58	0.39	6.89	0.61	-3.071	0.003	6.58	0.89	8.12	9.32	-1.187	0.238
LR5	6.98	0.44	7.25	0.56	-2.650	0.009	6.66	0.42	7.27	0.55	-6.339	<0.001
LR4	7.13	0.50	7.37	0.58	-2.308	0.023	6.81	0.43	7.32	0.44	-5.981	<0.001
LR3	6.85	0.41	7.12	0.47	-3.189	0.002	6.49	0.40	6.91	0.46	-4.927	<0.001
LR2	5.97	0.43	6.29	0.43	-3.856	<0.001	5.81	0.41	6.18	0.36	-5.011	<0.001
LR1	5.53	0.39	5.72	0.44	-2.388	0.019	5.32	0.35	5.69	0.42	-5.514	<0.001
LL1	5.51	0.41	5.73	0.41	-2.759	0.007	5.31	0.33	5.71	0.39	-4.431	<0.001
LL2	6.03	0.41	6.32	0.45	-3.460	0.001	5.85	0.42	6.18	0.37	-4.225	<0.001
LL3	6.88	0.40	7.14	0.51	-2.931	0.004	6.58	0.41	6.96	0.46	-4.431	<0.001
LL4	7.13	0.46	7.41	0.54	-2.832	0.006	6.82	0.42	7.38	0.50	-6.097	<0.001
LL5	7.06	0.70	7.30	0.74	-1.736	0.086	6.77	0.75	7.30	0.55	4.095	<0.001

\* $p \leq 0.05$  is significant, SD: standard deviation, UR: upper right, UL: upper left, LR: lower right, LL: lower left

**Table 2:** Comparison of MD dimensions of teeth between spaced and normal

	<i>Gender</i>											
	<i>Male</i>						<i>Female</i>					
	<i>Group</i>			<i>Group</i>			<i>Group</i>			<i>Group</i>		
	<i>Normal</i>		<i>Spaced</i>		<i>t</i>	<i>"p" value</i>	<i>Normal</i>		<i>Spaced</i>		<i>t</i>	<i>"p" value</i>
<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>	<i>Mean</i>			<i>SD</i>	<i>Mean</i>	<i>SD</i>			
UR5	6.64	0.37	6.42	0.39	2.954	0.004	6.45	0.42	6.39	0.41	0.659	0.512
UR4	7.16	0.48	6.80	0.37	4.261	<0.001	6.92	0.36	6.77	0.39	1.978	0.052
UR3	7.90	0.48	7.65	0.41	2.880	0.005	7.48	0.45	7.22	0.49	2.850	0.005
UR2	6.88	0.53	6.56	0.57	3.004	0.003	6.77	0.61	6.23	0.55	4.757	<0.001
UR1	8.69	0.49	8.46	0.56	2.296	0.023	8.49	0.49	8.05	0.54	4.429	<0.001
UL1	8.69	0.53	8.46	0.56	2.117	0.037	8.39	0.65	8.07	0.53	2.777	0.007
UL2	6.82	0.48	6.52	0.57	2.945	0.004	6.64	0.50	6.17	0.71	3.888	<0.001
UL3	7.90	0.44	7.56	0.45	3.865	<0.001	7.41	0.46	7.16	0.49	2.720	0.008
UL4	7.08	0.47	6.84	0.35	2.993	0.003	6.88	0.38	6.76	0.39	1.515	0.133
UL5	6.58	0.39	6.46	0.61	1.215	0.224	6.58	0.89	6.31	0.48	1.950	0.055
LR5	6.98	0.44	6.71	0.52	2.892	0.005	6.66	0.42	6.55	0.43	1.281	0.203
LR4	7.12	0.50	6.69	0.38	5.051	<0.005	6.81	0.43	6.58	0.39	2.737	0.007
LR3	6.85	0.41	6.63	0.35	2.908	0.004	6.49	0.40	6.22	0.44	3.344	0.001
LR2	5.97	0.43	5.73	0.32	3.238	0.002	5.81	0.41	5.38	0.45	5.019	<0.005
LR1	5.53	0.39	5.23	0.41	3.808	<0.005	5.32	0.35	5.01	0.44	3.934	<0.005
LL1	5.51	0.41	5.29	0.34	2.954	0.004	5.31	0.33	4.96	0.37	5.119	<0.005
LL2	6.03	0.41	5.77	0.34	3.491	0.001	5.85	0.42	5.49	0.41	4.480	<0.005
LL3	6.88	0.40	6.64	0.36	3.165	0.002	6.58	0.41	6.22	0.40	4.617	<0.005
LL4	7.13	0.46	6.73	0.37	4.825	<0.005	6.82	0.42	6.66	0.38	2.130	0.036
LL5	7.06	0.70	6.72	0.48	2.886	0.005	6.77	0.75	6.60	0.46	1.414	0.161

\* $p \leq 0.05$  is significant, SD: standard deviation, UR: upper right, UL: upper left, LR: lower right, LL: lower left

**Table 3:** Comparison of TTM and arch perimeter in the three groups

			Group						
			Normal		Crowded		Spaced		"p" value
			Mean	SD	Mean	SD	Mean	SD	
TTM maxilla	Gender	Male	74.10	3.92	77.61	4.37	71.74	3.15	<0.001
		Female	71.82	3.33	76.49	4.19	69.20	3.73	<0.001
TTM mandible	Gender	Male	64.84	3.30	67.73	3.71	62.18	2.82	<0.001
		Female	62.90	5.35	66.79	3.65	59.50	3.13	<0.001
Arch perimeter maxilla	Gender	Male	75.51	4.83	71.71	4.03	79.11	4.68	<0.001
		Female	72.33	3.26	68.93	3.43	75.51	3.86	<0.001
Arch perimeter mandible	Gender	Male	63.28	6.32	60.96	3.64	67.89	3.83	<0.001
		Female	61.05	3.59	58.50	3.69	64.56	3.60	<0.001

\* $p \leq 0.05$  is significant, SD: standard deviation

**Table 4:** Comparison of arch dimensions in the three groups

			Group						
			Normal		Crowded		Spaced		"p" value
			Mean	SD	Mean	SD	Mean	SD	
Inter canine maxilla	Gender	Male	27.10	6.66	25.59	2.51	28.10	3.34	0.002
		Female	25.45	1.48	24.77	2.04	26.53	2.59	<0.001
Inter premolar maxilla	Gender	Male	30.25	2.20	27.69	2.62	32.00	3.62	<0.001
		Female	28.26	1.51	25.95	2.13	29.67	2.92	<0.001
Inter molar maxilla	Gender	Male	37.89	2.51	35.50	3.05	39.32	3.20	<0.001
		Female	35.41	2.12	33.47	2.68	36.23	3.48	<0.001
Inter canine mandible	Gender	Male	20.53	3.04	20.32	2.19	22.17	2.55	0.001
		Female	19.76	1.36	19.89	1.56	21.22	1.93	<0.001
Inter premolar mandible	Gender	Male	27.89	3.58	25.78	2.06	29.72	2.44	<0.001
		Female	25.93	1.48	24.11	2.02	27.56	2.25	<0.001
Inter molar mandible	Gender	Male	34.44	2.76	32.78	2.86	36.48	2.22	<0.001
		Female	32.03	2.85	30.51	2.38	33.72	2.67	<0.001

\* $p \leq 0.05$  is significant, SD: standard deviation

value was 20.53, 20.32, and 22.17 for normal, crowded, and spaced dentitions, respectively.

While the female mean value was 19.76, 19.89, and 21.22, for normal, crowded, and spaced dentitions, respectively.

#### Inter Premolar Width

In the maxilla, the male mean value was 30.25, 27.69, and 32.00 for normal, crowded, and spaced dentitions, respectively. While the female mean value was 28.26, 25.95, and 29.67 for normal, crowded, and spaced dentitions, respectively. In the mandible, the male mean value was 27.89, 25.78, and 29.72 for normal, crowded, and spaced dentitions, respectively. While the female mean value was 25.93, 24.11, and 27.56 for normal, crowded, and spaced dentitions, respectively.

#### Inter Molar Width

In the maxilla, the male mean value was 37.89, 35.50, and 39.32 for normal, crowded, and spaced dentitions, respectively. While the female mean value was 35.41, 33.47, and 36.23 for normal, crowded, and spaced dentitions, respectively. In the mandible, the male mean value was 34.44, 32.78, and 36.48 for normal, crowded, and spaced dentitions, respectively. While the female mean value was 32.03, 30.51, and 33.72 for normal, crowded, and spaced dentitions, respectively. ANOVA revealed highly statistically

significant discrepancies between the compared mean values in the three examined groups in both maxilla and mandible ( $p \leq 0.05$ ).

The result of this study indicates that crowded arches have the widest MD size of teeth and a smaller arch dimension. Whereas, spaced dentition has a narrower MD size and greater arch dimension.

## DISCUSSION

MD tooth size and arch dimensions are important aspects of orthodontic assessment and treatment planning. Harmony relationship between tooth size and arch length result in good alignment and optimum occlusion and disproportion lead to the development of dental crowding and spacing.<sup>3</sup> The purpose of this study was to evaluate whether normal arches differ from crowded and spaced arches in tooth and arch dimensions.

The mean age of the sample in the present study was  $19.5 \pm 2.2$ . According to Golwalkar and Msitry<sup>11</sup> and Puri et al.,<sup>3</sup> the young age group was ideal because of less mutilation and less attrition in most of the subjects. Thus, the effect of these factors on the MD tooth width would be negligible. Inter canine and inter molar widths did not change after 13 years in females and 16 years in males,<sup>11,18</sup> so it was assumed that the widths in this group were expected to have passed their active growth phase, and, therefore, had stable arch widths.

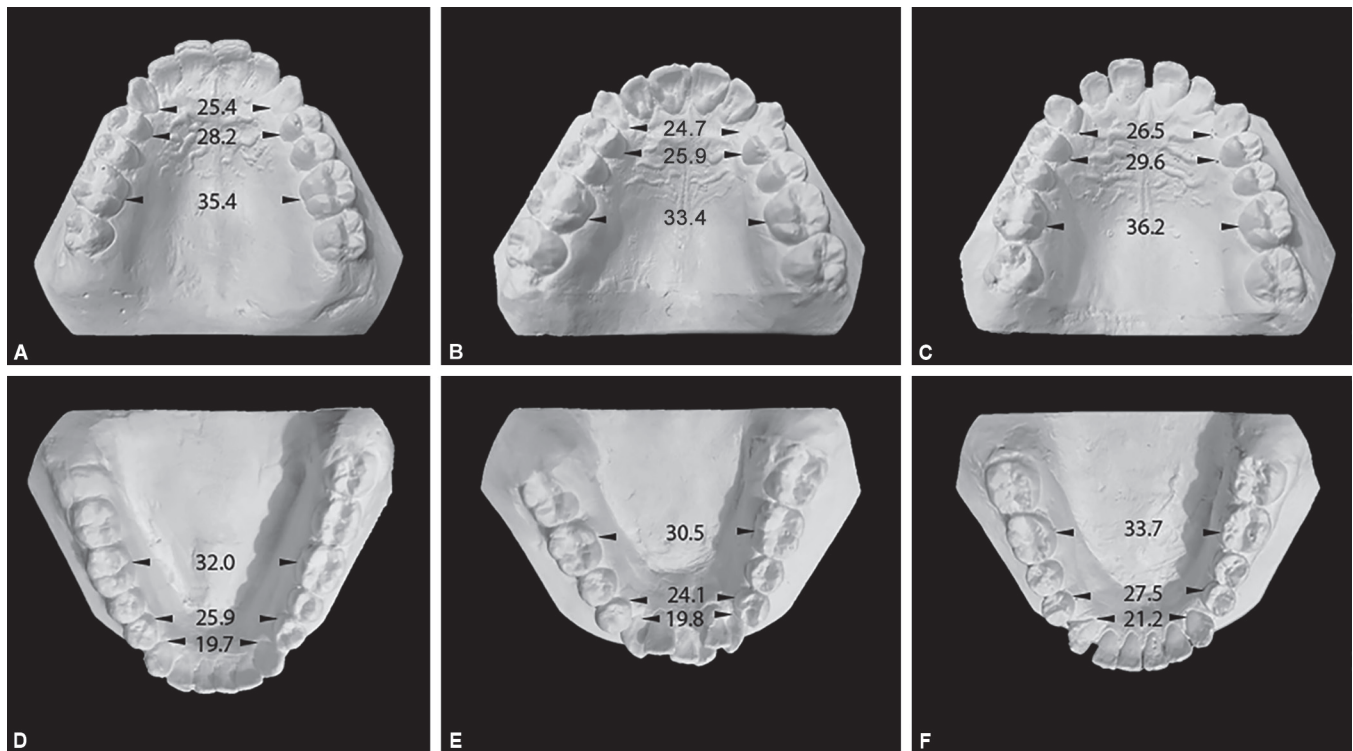


Fig. 1: Statistical female averages: (A, B) normal group, (C, D) crowded group, and (E, F) spaced group

Type of malocclusion can also affect the amount of crowding and spacing present in the arch. Fattahi et al.<sup>19</sup> conclude that subjects with Angle's class III malocclusion had a significantly greater prevalence of tooth size discrepancy than those with Angle's class I and class II malocclusion. In the current study, all samples had Angle's class I dental occlusion and this excluded other factors that might contribute to variation in tooth size.

The main finding of this study is that subjects with dental crowding were more likely to have smaller dental arch measurements and increased in tooth material than subjects with a normal arch; these findings are in agreement with Poosti and Jalali<sup>8</sup> who found a statistically significant difference in both tooth diameter and transverse arch dimension between the crowded and normal groups. Crowded arches have significantly smaller maxillary arch width and larger tooth size when compared to the noncrowded group. Our study results were also in agreement with Kaundal et al.<sup>9</sup> who found that crowded male samples had increased TTM with decreased arch perimeter and intermolar width. The crowded female sample had increased TTM with reduced arch perimeter and arch length.

In this study, the mean values of the MD tooth width of crowded arches were significantly wider than in the normal group in all teeth ( $p \leq 0.05$ ) except for mandibular left second premolar in male maxillary left second premolar in the female. A contributory factor for this finding might be that the size of the mandibular second premolar is among the most frequently anomalous teeth.<sup>20</sup> Bugaighis and Elorfi,<sup>10</sup> found that the mean values of the MD tooth width of crowded arches were significantly wider than in the normal group ( $p \leq 0.01$ ) except for the widths of the upper left lateral incisor ( $p = 0.068$ ). Moreover, Faruqui et al.<sup>1</sup> found that there was a statistically significant difference between crowded and normal arches in the MD dimensions of upper canines, upper first molars, lower incisors ( $p < 0.05$ ). Arif et al.<sup>16</sup> found a significant difference

between crowded and normal arches only in the MD dimensions of the right lateral incisor ( $p = 0.001$ ). In contrast, Howe et al.<sup>7</sup> do not agree with the idea and show no such correlation. The differences of selection, number of the sample size, methods used in various studies could be the reason for dissimilar findings.

In the present study, the arch perimeter was found to be significantly shorter in crowded individuals than in normal individuals. This supports the role played by reduced arch perimeter in the etiology of dental crowding. Similar findings have been reported by Randzic,<sup>6</sup> Howe et al.,<sup>7</sup> and Arif et al.<sup>16</sup>

Arch dimensions in crowded arches were smaller than those in normal and spaced arches, statistically, significant differences were found at all level both in maxilla and mandible. Golwalkar and Msitry<sup>11</sup> and Howe et al.<sup>7</sup> have shown similar results.

Comparison between the MD width of the normal and spaced dentitions revealed that significant differences were found in all teeth except maxillary left second premolar in male and maxillary right second premolar, left first premolar, mandibular right and left second premolar in the female. Bugaighis and Elorfi<sup>10</sup> found that there was a trend for smaller tooth widths in spaced dentitions compared to normal ones, this was only significant in the maxillary left central incisor, maxillary right and left lateral incisors, maxillary right first premolar, mandibular right lateral incisor, and mandibular right canine ( $p < 0.05$ ). On the other hand, Faruqui et al.<sup>1</sup> revealed statistical significant between space, and normal arches only in upper incisors, lower canines, and lower premolars. These dissimilar findings may be related to the characteristic of the particular population examined.

Spaced arches were presented with wide maxillary and mandibular arch width when compared to normal arches both in male and female. In contrast, Faruqui et al.<sup>1</sup> found statistically significant differences between spaced and normal arches only in mandibular arches. On the other hand, Steigman et al.<sup>12</sup> found that

spaced dentition in male patients' intercanine and interpremolar distances were greater only in the maxilla. The variation in these results can be partially explained by the differences in the genetic and ethnic background of the different study populations.

The result collected from this study are clinically significant and they indicate that both tooth crown size and arch width are risk factors for the development of crowding and spacing. Thus, an orthodontist should consider these factors in the initial stage of planning treatment to decide the need for interdental stripping, crown recontouring, prosthetic reconstruction or extraction.

Our study also suggests early interception and expansion of cases with crowding in the mixed dentition stage to reduce the severity of crowding in adult life, because of mature dental arches unlikely to be expanded without limitation.<sup>7</sup>

Future studies should be carried out evaluating the arch dimension of normal Sudanese subjects in the mixed dentition stage, to determine the real need for arch expansion of crowded arches at an early stage.

The limitation of the study is the small sample size. Although the sample size was considered to be adequate, future studies should include Sudanese adults from different parts of Sudan.

## CONCLUSION

The MD dimensions of all teeth are greater in crowded arches and smaller in spaced arches as compared to the teeth in normal dental arches, the only exception the second premolar tooth that shows no statistical difference between the three groups. The crowded group shows the highest value in TTM followed by the normal group and lastly the spaced group. The spaced group shows the highest value in the arch perimeter and the widest value in arch dimension at all levels, followed by the normal group, and lastly the crowded group.

Hence, we concluded that differences in the tooth and arch dimensions are associated with dental crowding and spacing. These factors should consider during orthodontic diagnosis and treatment planning.

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