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Original Article

Determination of the Combined Mesio-distal Widths of the Permanent Mandibular Incisors and that of the Maxillary and Mandibular Canines and Premolars in a Group of Egyptian Children in Suez Governorate: A Cross-sectional study

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Abstract

Background: Tooth size specifically the mesiodistal dimension has an important role in normal occlusion and in arch space analysis as it affects treatment planning and the final results in orthodontic treatment. Tooth size differs among and within populations. **Objectives:** The aim of the current study was to measure the mesiodistal widths of the mandibular incisors, maxillary and mandibular canines and premolars in a group of Egyptian children in Suez Governorate and to correlate between the widths of these teeth to formulate normative data for the Egyptian children. **Materials and Methods:** 12-15 year old children (150 boys and 150 girls) from Suez Governorate were included in the present study. The measurements of the mesiodistal widths of the teeth were conducted on dental casts by a digital caliper **Results:** The means of the mesiodistal widths of the boys' teeth were significantly larger than those of the girls. Also, there was no statistically significant difference between the right and left sides in girls. However, in males the right mandibular second premolar was significantly bigger than the left side.**Conclusion:** Sexual dimorphism is present between boys and girls where boys had larger teeth than girls. There were no statistically significant differences between the right and left sides in girls. But in boys only the mandibular second premolar showed slight statistically significant difference. The mandibular permanent incisors can be used in the prediction of the mesiodistal widths of the maxillary and mandibular permanent canines and premolars due to positive correlation between them

.Keywords: Tooth size, mesiodistal width, Egyptian children.

1. Introduction

Teeth development starts in the intrauterine life. Their size is controlled by hereditary factors and is usually unaffected by external factors but if subjected to infection, trauma or pathological condition, hypoplasia or hyperplasia may be expected **(Hussein et al, 2009).** Mesiodistal crown diameter, which is also known as tooth size, tooth crown size or tooth mesiodistal width is defined as the distance between the two parallel lines, which are perpendicular to the mesiodistal axis of the tooth tangential to the most mesial and the most distal points of the crown along a parallel line to the occlusal plane **(Hasegawa, 2014).**

Tooth size and shape varies from one person to another, from males and females and from one ethnic group to the other depending on genetic factors **(Moon et al, 2006).** Sexual dimorphism is the differences in the size or shape of teeth between males and females

of the same species **(Bunger et al, 2014).** Environment and genetics both affect tooth size and it's strongly linked to sex and ethnicity. Males' teeth are larger in size than those of the females and Africans have larger teeth than Europeans **(Altherr et al, 2007).** A study was carried out to compare the mesiodistal crown dimensions in three populations from Egypt, Mexico and United States. The sample consisted of 54 Egyptian subjects (30 males and 24 females), 57 subjects (35 males and 22 females) from Iowa, United States and 60 subjects (26 males and 34 females) from Mexico. All subjects had normal class I occlusion with no history of orthodontic treatment. The results showed that there was a difference in the mesiodistal dimensions between the three populations. Also, there was sexual dimorphism where males had larger teeth than females among each population especially in the canines and premolars and finally there was no statistical significance between the right and left sides for all populations **(Bishara et al., 1989).**

Mesiodistal width in human populations is an important focus in many studies as it can be used in forensic investigations, human evolution, biological issues and clinical dentistry. In clinical dentistry, the relationship between the mesiodistal crown diameter and arch alignment is important to determine malocclusion and crowding as a correct mesiodistal crown diameter relationship between the upper and lower teeth is essential for proper inter-digitation, over-jet and overbite in final orthodontic treatment **(Hattab, 2013).** Malocclusion is a common esthetic and functional problem in the world. It's a developmental condition caused by alteration in normal development **(Jahan & Hossain, 2011).** The majority of malocclusion, which starts during the mixed dentition period, can be treated and eliminated in its severity if it was managed early **(Felicio et al, 2010).** Early diagnosis and treatment of malocclusion is important in orthodontics. For this reason, accurate arch space analysis is needed to determine the appropriate treatment that may include space maintenance, space regaining, and guidance of eruption, serial extractions or periodic check-ups of the patient **(Kundi et al, 2012 and Abdelbagi et al, 2016).** Arch length analysis is the prediction of the meisodistal widths of the un-erupted permanent canines and premolars to detect the discrepancy between the available and required spaces. It is of great importance in determining and handling the developing occlusion of growing children. Since it will aid in figuring out if the posteriorly available space is adequate for the good alignment of the permanent teeth or not **(Memon et al, 2012 and Abdelbagi et al, 2016).** Arch space analysis can be done either through radiographs**,** prediction tables or both **(Burhan and Nawaya, 2014).**

To the present date, few studies on the mesiodistal dimensions of teeth of the Egyptian population were found in the literature. For that reason, this study was carried out as part of a project adopted to gather data from different Governorates in Egypt on the mesiodistal widths of the permanent mandibular incisors, maxillary and mandibular canines and premolars. This will help in raising the dental care quality for Egyptian children and adolescents.

2. Subjects and Methods

As a cross-sectional study was planned, in which multiple regression analyses were performed with 20 independent variables, the expected multiple regression coefficient was estimated to be R=0.50. In this study, 300 subjects needed to be recruited with Probability of Type I Error (α)= 0.05 and power= 90.0% (VanVoorhis et al., 2001). 150 females and 150 males were selected from Nabwia Moussa Preparatory Mixed School in Suez Governorate. The ethical committee in Faculty of Dentistry, Cairo University approved this study. A permission letter that explains the aim of the study was presented to the head of the educational region for his approval to enter the governmental schools. A written consent was given to the school's principal in charge of the subjects, who were included in the study to sign before the beginning of the procedure.

Inclusion Criteria:

- Age: 12-15 years.
- Full set of permanent dentition from left first permanent molar to right first permanent molar in the upper and lower arch.
- No apparent orthodontic problem.
- No previous history of orthodontic treatment.
- No clinically apparent proximal caries, crown fractures, malformed teeth, interproximal restorations or any dental anomalies.
- No apparent systemic conditions or genetic syndromes (medically free) that may affect the mesiodistal dimensions of the included teeth.
- Exclusion Criteria:
- Missing permanent teeth or retained primary ones.
- Dentition exhibiting morphological anomalies.
- Crowding, rotation, increased overjet or any other orthodontic condition.

Patients were divided into two groups according to gender (150 boys and 150 girls).

Materials:

The materials used were:

1. Disposable diagnostic sets.
2. 150 pairs of perforated stock metal trays size 1*
3. Multiple rubber bowls and spatulas.
4. Irreversible hydrocolloid impression material[1]**.
5. Hard dental stone***.
6. Digital Caliper with a calibrated digital micrometer****, read to the nearest 0.01mm used to measure the tooth size.

Method:

1. Clinical examination:

A diagnostic chart was made for each student including medical and dental history. Dental examination was made on a student's bench in the classroom using a disposable diagnostic set that includes a mouth mirror and a probe.

Examination procedures:

A. Impression taking:

Impressions of both the upper and lower arches were taken by fast setting irreversible hydrocolloid impression material (Tropicalgin impression material-Zhermack-Italy) using suitable size perforated study trays. The material was used according to the manufacturer's instructions regarding mixing and setting time. The impressions were rinsed under running water, wrapped with moist gauze and placed in a polyethylene bag with the student's name written on the bag until it was poured.

B. Study casts and model trimming:

Each impression was poured within one hour using dental stone to avoid any dimensional changes. The stone was mixed according to the manufacturer's instructions. The casts were trimmed at Digital Dental Academy laboratory.

C. Measurements taken from the study casts:

Measurements were taken perpendicular to the long axis of the tooth, with a digital caliper entering the interproximal area from the anatomic mesial contact point to the anatomic distal contact point of each tooth parallel to the occlusal plane (Priest & Hunter, 1960).

All the dimensions were measured directly from the study models using a digital caliper especially designed for dental use. The measurements were recorded in excel sheets to the nearest 0.01mm.

The following measurements were recorded from each cast for each student:

- Mesio-distal width of the four mandibular incisors.
- Mesio-distal width of the mandibular right canine, first and second premolars.
- Mesio-distal widths of the mandibular left canine, first and second premolars.
- Mesio-distal width of the maxillary right canine, first and second premolars.
- Mesio-distal widths of the maxillary left canine, first and second premolars.

Measuring Device:

According to the manufacturer's instructions, the digital caliper simplified the reading of the value from the display. The display could be switched from 'millimeter' to 'inches' and had the function of zeroing the display at the beginning or anywhere along the slide. The slide of the digital caliper may also be controlled through thumb roller or locked using a thumbscrew. The readings were displayed to the nearest 0.01mm.

Statistical analysis:

Statistical analysis was performed with IBM® SPSS® (SPSS Inc., IBM Corporation, NY, USA) Statistics Version 23 for Windows. Data were presented as mean, standard deviation (SD), frequency and percentage when appropriate. Data were explored for normality using Kolmogorov-Smirnov and Shapiro-Wilk tests. All tested parameters showed a parametric distribution, so Independent t-Test used to compare between boys and girls. Pearson Correlation Coefficient was used to determine correlations between all parameters for boys and girls. The significance level was set at $P \leq 0.05$

3. Results

Table 1 shows the number and distribution of students among different age groups. The highest number of participants was observed at 14 years old, while the least number of participants was shown at 12 years old. Figures 1 and 2 show the mesiodistal width of maxillaryand mandibular teeth in both boys and girls.

The comparison between boys and girls for the mesiodistal width of teeth revealed that there was a statistically significant difference between the boys and

[1] *Misr Dental-Egypt
**Tropicalgin impression material-Zhermack-Italy
***HTM Dent-Turkey
****ELORA, Germany

girls. The means of the mesiodistal widths of the boys' teeth were significantly larger than those of the girls.

There wasn't a statistically significant difference between the mesiodistal widths of the right and left teeth in boys except for the mandibular second premolar (Table 2)

There was positive significant correlation between the mesiodistal widths of maxillary right canine and premolars & the mesiodistal widths of the lower incisors in both boys and girls; r=0.418; p≤0.001

Additionally, there was a positive significant correlation between the mesiodistal widths of maxillary left canine and premolars & the mesiodistal widths of the mandibular incisors in both boys and girls; r=0.310; p≤0.001. The same was true for their right counterparts with r=0.624 and a p-value ≤0.001

As for the lower arch, there was positive significant correlation between the mesiodistal widths of mandibular left canine and premolars & the mesiodistal widths of the mandibular incisors in both boys and girls; r=0.578; p≤0.001, which was seen also in the right side (r=0.574; p≤0.001)

A positive significant correlation was found between the mesiodistal widths of mandibular right canine and premolars & the mesiodistal widths of the mandibular left canine and premolars was in both boys and girls; r=0.963; p≤0.001, the same was seen in their maxillary counterparts (r=0.761; p≤0.001)

Finally, there was positive significant correlation between the mesiodistal widths of maxillary left canine and premolars & the mesiodistal widths of the mandibular left canine and premolars; r=0.484; p≤0.001

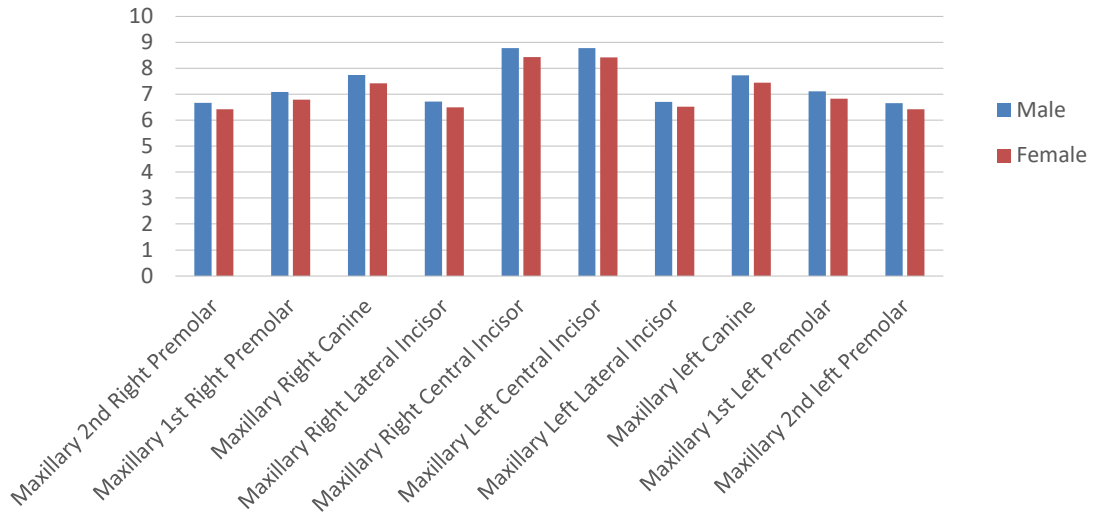

Figure (1): Bar chart for the Mesiodistal Width of maxillary teeth under study for males and females.

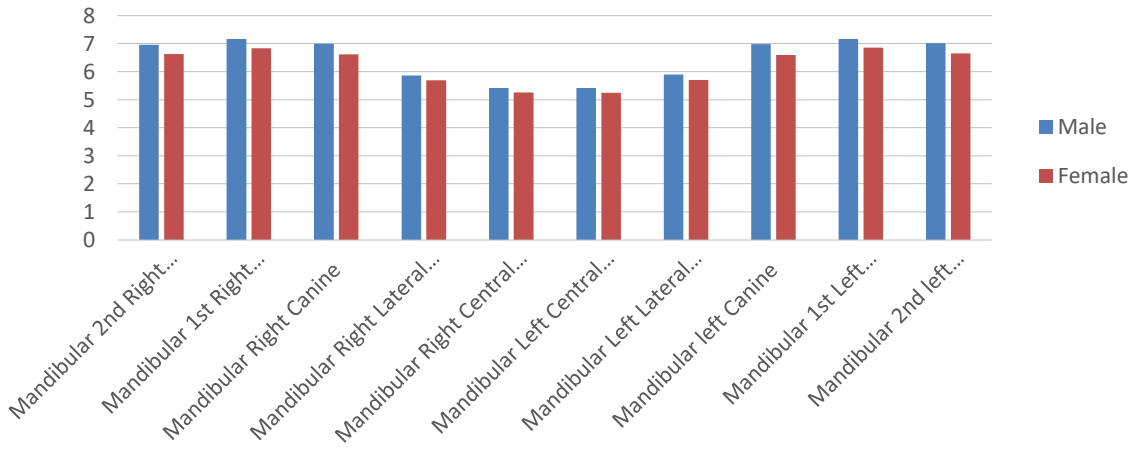

Figure (2): Bar chart for the Mesiodistal Width of mandibular teeth under study for males and females.

Table (1): Frequency and percentage for the age of the children.

		No. of children.	% From total number
Age	12.5	5	1.7%
	12.9	1	0.3%
	13	80	26.7%
	13.5	7	2.3%
	14	122	40.7%
	14.5	4	1.3%
	15	81	27.0%
	Total	300	100.0%

Table (2): Mean and standard deviation (SD) of the mesiodistal widths of the right and left teeth in boys.

	Paired Differences		P-value
	Mean	**SD**	
Mandibular 2nd Right Premolar - Mandibular 2nd left Premolar	-0.05340	0.22017	0.003*
Mandibular 1st Right Premolar - Mandibular 1st Left Premolar	-0.00200	0.22213	0.912 NS
Mandibular Right Canine - Mandibular left Canine	0.00913	0.15991	0.485 NS
Mandibular Right lateral Incisor - Mandibular Left lateral Incisor	-0.01873	0.30439	0.452 NS
Mandibular Right Central Incisor - Mandibular Left Central Incisor	-0.00560	0.16939	0.686 NS
Maxillary 2nd Right Premolar - Maxillary 2nd left Premolar	0.01282	0.20620	0.449 NS
Maxillary 1st Right Premolar - Maxillary 1st Left Premolar	-0.01839	0.20886	0.284 NS
Maxillary Right Canine - Maxillary left Canine	0.00805	0.21789	0.653 NS
Maxillary Right lateral Incisor - Maxillary Left lateral Incisor	0.02181	0.25270	0.294 NS
Maxillary Right Central Incisor - Maxillary Left Central Incisor	-0.01530	0.16389	0.256 NS

4. Discussion

Teeth size is one of the critical factors that have an effect on the development of occlusion. **(Janosevic et al, 2006)**

Tooth size varies among different races and also varies among different individuals. Tooth size is affected by genetics, nutritional and environmental factors. **(Bishara et al, 1989, Hashim & Al-Shalan, 2003, Janosevic et al, 2006, Kaur et al, 2014)**

The tooth size of the primary and permanent teeth is inherited independently so the size of the permanent teeth cant be determined from the size of the primary teeth. **(Janosevic et al, 2006)**

Arch space analysis is an essential procedure for the accurate diagnosis towards a successful orthodontic treatment. It helps in the prediction of the mesiodistal diameter of the un-erupted teeth to determine whether there is a variation between the size of the teeth and the size of the dental arches during the mixed dentition stage. The results obtained from the mixed dentition analysis aids in determining the different lines of treatment whether guidance of eruption, space regaining, serial extraction or follow up. **(Galvao et al, 2013)**

This is a cross sectional study conducted on 300 Egyptian students (150 boys and 150 girls) that were selected from Nabwia Moussa preparatory mixed school in Suez governorate with an age range from 12-15 years of age.

In this study the mesiodistal widths of the mandibular incisors and the maxillary and mandibular canines and premolars were measured. The sample size was similar to that used by **Hammad and Abdellatif, 2010 and the same as Bunger et al, 2014** who used equal number of males and females.

The 12 to 15-age range were used to prevent any possible complications as teeth attrition and wear that might cause changes in the mesiodistal dimensions of teeth. This was also stated by **Bherwani and Fida, (2010), Bunger et al, (2014), Kaur et al (2014), Gamal et al, (2016), Al-Sayed et al, (2016), Eissa et al, (2016)** and **Emam et al, (2016)**.

From the inclusion criteria for this study were that the students should have neither an orthodontic problem nor a previous orthodontic treatment to avoid the possibility of interproximal reduction. Also the student should have no apparent systemic condition or genetic syndrome that might alter the mesiodistal dimensions of teeth. A full set of permanent dentition should be present with no proximal caries, congenitally missing, malformed, broken or chipped teeth to allow the correct positioning of the measuring instrument. **Al Bitar et al (2008), Bunger et al (2014), Kaur et al (2014), Gamal et al, (2016), Al-Sayed et al, (2016), Eissa et al, (2016) and Emam et al (2016)** also stated similar criteria.

Irreversible hydrocolloid impression material was used in taking the impressions because of its accuracy in reproducing the fine details, its compatibility with all types of dental stone, its good taste thus can be accepted by the patient, its ease of manipulation, and fast setting. In order to reduce the potential errors in impression taking, the manufacturer's instructions were strictly followed and the same handling techniques were used for all subjects as suggested by **Bugaighis et al., (2013).** The same method was employed by **Hahsim and Al-Shalan (2003)**, **Kaur et al (2014), Gamal et al, (2016), Al-Sayed et al, (2016), Eissa et al, (2016) and Emam et al (2016).**

Dental stone type III was used within one hour after taking the impressions for pouring dental casts to avoid any dimensional as it has high strength and reproduces fine details. This was also used by **Hahsim and Al-Shalan (2003**), **Bell et al., (2003), Kaur et al (2014), Correia et al, (2014), Gamal et al, (2016), Al-Sayed et al, (2016), Eissa et al, (2016) and Emam et al (2016).**

The measurements were taken from the dental casts rather than from the subjects' mouths as they serve as a diagnostic tool providing 3D study of the dental arches for occlusion without soft tissue interference, which helps in diagnosis and treatment planning. Also measurements on the dental casts are reproducible and reliable. This results and explanation were in line with **Moon et al, (2006) and Correia et al, (2014).**

They also help in determining the size and shape of each tooth. In addition to the form, length, width and symmetry of the arch and the occlusal relationship. **(Gaddan et al, 2015)**

Digital calipers were used in the measurements of the mesiodistal dimensions of the teeth on the dental casts. **Zilberman, (2003)** recommended their use in any scientific procedure. This was also employed by **Bunger et al (2014), Kaur et al** (**2014), Abd-Elmonem et al (2015), Gamal et al, (2016)** and **Al-Sayed et al (2016).**

The results of this study showed that males had statistically significant larger teeth than the females. This was also mentioned by **Bishara et al, (1989), Jaroontham J and Gofey K, (2000), Al-Janabi M F. (2005), Goyal et al (2006)**, **Uysal et al, (2009), Hammad and Abd-ElLatif, (2010), Burhan and Nawaya, (2014), Abd-Elmonem et al (2015), Gamal et al, (2016)**, **Al-Sayed et al (2016), Eissa et al, (2016)** and **Emam et al (2016).**

This sexual dimorphism is suggested to be due to sex-linked inheritance and sex-hormonal influences **(Al-Janabi, 2005).**

Sexual dimorphism may be due to:

- Longer amelogenesis phase in males than in females resulting in larger thickness of enamel. Whereas, the calcification in females ends earlier than the males.
- Sex chromosomes also affect the tooth size where 'Y' chromosome has an effect on the timing and rate of body development resulting in slower maturation in males. **(Kundi I, 2015).**

In the current study, by comparing between the right and left sides in females there weren't any statistically significant differences as explained also by **Hammad and Abdellatif, (2010), Abd-Elmonem et al (2015), Gamal et al, (2016)**, **Al-Sayed et al (2016), Eissa et al, (2016)** and **Emam et al (2016).** In males there weren't any statistical differences except for the lower second premolar, which doesn't go in agreement with **Abd-Elmonem et al (2015), Gamal et al, (2016)**, **Al-Sayed et al (2016), Eissa et al, (2016)** and **Emam et al (2016).** This may be attributed to genetic and environmental factors that affect tooth development.

In this study, positive significant correlation was found between the mesiodistal widths of the upper and lower left canine and premolars and the mesiodistal widths of the lower incisors. Moreover, there was a positive correlation between the mesiodistal widths of the upper and lower right canine and premolars and the mesiodistal widths of the lower incisors. This was similar to the results mentioned by **Burhan and Nawaya, (2014), Burhan and Nawaya, (2014), Gamal et al (2016), Al-Sayed et al, (2016), Eissa et al, (2016) and Emam et al (2016)** who attributed this result to the fact that these teeth undergo the same developmental stages.

In addition, there was positive correlation coefficient between the mesiodistal widths of the lower right canine and premolars and the mesiodistal widths of the lower left canine and premolars. This results go in accordance with **Burhan and Nawaya, (2014), Gamal et al, (2016), Al-Sayed et al, (2016), Eissa et al, (2016) and Emam et al (2016).** Likewise positive correlation coefficient was found between the mesiodistal widths of the upper right canine and premolars and the mesiodistal widths of the upper left canine and premolars. This was in accordance with **Burhan and Nawaya, (2014), Gamal et al, (2016)**, **Al-Sayed et al, (2016), Eissa et al, (2016) and Emam et al (2016).** These findings may be due to genetic and environmental factors where teeth on the right and left sides should be in an appropriate relationship for proper facial esthetics.

Besides, positive correlation was also found between the mesiodistal widths of the upper right canine and premolars and the mesiodistal widths of the lower right canine and premolars. This was similar to the results concluded by **Burhan and Nawaya, (2014), Al-Dlaigan et al, (2015), Gamal et al, (2016)**, **Al-Sayed et al, (2016), Eissa et al, (2016) and Emam et al (2016).** And finally the results in this study showed that, there was a positive correlation between the mesiodistal widths of the upper left canine and premolars and the mesiodistal widths of the lower left canine and premolars. And this was similar to the results shown by **Burhan and Nawaya, (2014), Al-Dlaigan et al, (2015), Gamal et al, (2016)**, **Al-Sayed et al, (2016), Eissa et al, (2016) and Emam et al (2016). Al-Dlaigan et al, (2015)** who attributed these findings to importance of the presence of harmony in the mesiodistal dimensions of the upper and lower teeth in achieving stable and functional occlusion

Conclusions

Based on the results of this study the following was concluded:

1. The presence of sexual dimorphism between boys and girls where boys had larger teeth than girls.
2. No statistically significant differences between the right and left sides in girls so clinicians can rely on the mesiodistal teeth widths of one side if the other side is missing.
3. No statistically significant differences between the right and left sides in boys except for the mandibular second premolar.
4. Positive significant correlation is present between the mesiodistal widths of the mandibular permanent incisors and the mesiodistal widths of the maxillary and mandibular permanent canines and premolars, which allows the mandibular permanent incisors to be used in their prediction

Recommendations

1. Each population should have their own data since the mesio-distal dimensions of teeth vary from one race to the other.
2. Measurements of the mesio-distal dimensions should be done separately for each gender because boys had larger mesio-distal teeth widths than girls, thus measurements of the mesio-distal dimensions should be done separately for each gender.
3. Prediction of the mesio-distal widths of the un-erupted maxillary and mandibular permanent canines and

premolars can be done with the use of the meiso-distal widths of the mandibular permanent incisors.

4. Detection of the mesiodistal widths of teeth on one side can be done by using the mesiodistal widths of teeth of the other side due to the positive correlation between the right and left sides except for the mandibular second premolar in males.
5. Further studies should be carried out all over Egypt to collect more data of the mesio-distal widths of the permanent mandibular incisors, maxillary and mandibular canines and premolars for the Egyptian population to have our own data for arch length analysis.

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