Dental Journal
Majalah Kedokteran Gigi

Dental Journal
(Majalah Kedokteran Gigi)
2020 June; 53(2): 93–98

Research Report

Correlation between age and dental arch dimension of Javanese children

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ABSTRACT

Background: *Dental arch form and dimension are fundamental factors in orthodontic diagnosis and treatment planning. Its dimension will increase, due to the eruption of teeth, and is also affected by ethnicity, nutrition, systemic disease, hormonal factors, and gender. Many teeth are erupting in 8–10-year-old children.* ***Purpose:*** *This study aimed to assess the correlation between age and dental arch dimension of Javanese children in good nutritional status for consideration of orthodontic treatment.* ***Methods:*** *This was a cross-sectional study with 66 children aged 8–10 years in a normal dentoskeletal relationship, grouped based on age as the subject. Each group consisted of 22 pairs of dental study models, male and female. Anterior and posterior size of dental arch length were measured by digital sliding calipers from the midpoint between the right and left permanent central incisors perpendicular to the inter-canines and inter-molars. The width was measured at the inter-canines and inter-molars.* ***Results:*** *Pearson's correlation test showed that there were significant correlations between age and maxillary dental arch lengths ($p = 0.01$, $r = 0.31$ for anterior, and $p = 0.043$, $r = 0.249$ for posterior).* ***Conclusion:*** *Based on this study, it can be concluded that there was a positive correlation between age and dental arch length of 8–10-year-old Javanese children in good nutritional status, especially in maxillary dental arch length.*

Keywords: *arch length; arch width; children; dental arch; dimension*

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INTRODUCTION

In patients who are growing, tooth development and bone maturation are widely used to determine the time of orthodontic treatment and the selection of treatment modalities.[1] The dental arch size will increase due to permanent tooth eruptions. It is influenced by the environment, nutrition, genetics, race, sex, and age.[2] Children aged 8–10 years are in the mixed dentition period. There are some permanent tooth eruptions that replace some primary teeth. The erupting teeth that occur in an 8-year-old child are permanent maxillary lateral incisors; in a 9-year-old, they are permanent mandible canines, and in a 10-year-old, they are permanent maxillary and mandible first premolars, and also permanent maxillary second premolars.[3]

Changes in the growth of the dentocraniofacial complex caused by poor nutrition can be reflected in the reduced space for tooth eruption[4]. Mack[1] states a significant relationship between weight status, determined by the BMI percentile, and dental age and cervical bone maturity. The BMI percentile increases with the increasing development of the teeth and bones. BMI is an easy measurement and calculation method, which is the most widely used diagnostic tool to identify the nutritional status of a population, and usually determines whether a person is underweight, healthy, or overweight.[5]

Lombardo et al.[6] find that dental arches can be affected by ethnicity. Its size, both in width and length, can be influenced by genetic factors, and the effect is very visible in size difference between maxilla and mandible.[7] The

Dental Journal (Majalah Kedokteran Gigi) p-ISSN: 1978-3728; e-ISSN: 2442-9740. Accredited No. 32a/E/KPT/2017.

DOI: 10.20473/j.djmkg.v53.i2.p93–98

dental arch dimensions were not similar for each different ethnic population.[8] Different ethnic populations will also have significant differences in the size of their teeth.[9] The Javanese are the most populous ethnicity in Indonesia. According to Jacob, Javanese are included in the Deutero-Malay ethnic group, which has characteristics such as wide nostrils and alae nasi and medium-thickness lips.[10]

Comprehensive diagnosis and treatment planning are factors that greatly determine the success of orthodontic treatment. Dental arch form and its dimensions are one of the fundamental factors in the diagnosis.[11] The dental arch dimension is explained by arch width, arch length, and arch perimeter.[12] The growth and development of dental arches are a continuous process with several changes during the period of child development. Changes occur in all dimensions continuously in adolescence to adulthood.[13] This condition is important for determining the diagnosis and orthodontic treatment planning, as well as post-treatment stability.[14] Many studies about the dimension of the dental arch, especially in Indonesia and the Javanese, are focused on adults.[15–18] This study aimed to know the correlation between age, dental arch length, and width in 8–10-year-old Javanese Indonesian children for consideration of orthodontic treatment.

MATERIALS AND METHODS

All procedures performed in this study involving human participants were approved by the Ethical Committee of the Faculty of Medicine and Health Sciences, Universitas Muhamadiyah Yogyakarta, No: 455/EP-FKIK-UMY/X/2018. This research was observational and analytic with a cross-sectional design, carried out in Grogol State Elementary School, Bantul Regency, Yogyakarta Special Region. The parents of the subjects had been informed of all the procedures of this study. Only children who were permitted by their parents could be the subjects of this study, and informed consent had been given by the parents of each child. The subjects of this study were taken by simple random sampling, and the sample size was calculated using this formula: $n = \frac{N}{1+N\,(d)^2}$; n = number of samples needed; N = number of population (154) 1; d = validity level selected (d = 0.1). The minimum sample size was 61, and in this study, the number of subjects was 66 children, male and female.

Inclusion criteria were Javanese children (until filial 2, descendants from Java), aged 8– 10 years old, good nutritional status, normal occlusion, overjet and overbite of 2–4 cm, and normal tooth position at contact points and contact surfaces. Meanwhile, the other criteria for the subjects were 8-year-old children whose maxillary permanent central incisors and mandible lateral incisors had erupted, 9-year-olds whose maxillary permanent lateral incisors had erupted, and 10-year-olds whose mandible permanent canines had erupted. The teeth which were measured were to be free of restorations, fractures, or proximal caries. Exclusion criteria were that the children have ever had or are in orthodontic treatment and facial trauma with clinical symptoms. The other exclusion criteria were that they had a systemic disease and had radices or caries/fractures/attrition involving the proximal wall and anomalous form of the teeth that were measured.

Nutritional statuses were determined based on Body Mass Index (BMI) for age, as stated in the Indonesian Minister of Health Decree Number 1995/MENKES/SK/XII/2010 concerning anthropometric standards for assessing children's nutritional status,[19] and good (normal) nutritional criteria were used in this study. The child's weight was measured using an electronic digital scale (QC Pass P: ES-BG00 DO01193281, the capacity of up to 180 kg) placed on a flat surface for recording weight. The height was recorded by using ordinary measuring tape fixed at the wall. The child was straight, the Frankfurt plane was horizontal, and the head-pressing piece was gently lowered until it was touching the top of the child's head. The subjects aged 8–10 years in good nutritional status had their dental impressions taken using alginate impressions (Aroma fine plus normal set, GC Corporation, Tokyo, Japan) to get dental study models grouped by age. Reference points were determined for each dental study model for measuring its dimension, both for dental arch length and width. The reference points were the midpoint between the right and left permanent central incisors, the cusp tip of the right and left canines, and the tip of the mesiobuccal cusp of the right and left permanent first molars.

Using a digital sliding caliper (Mitutoyo digimatic caliper, code no. 573-721-20, model no. NTD12-P6"M, serial no. 0000644, Japan), the dental arch length was measured from the midpoint between the right and left permanent central incisors perpendicular to the midpoint of the line which was connecting the right-left cusp tip of the canine teeth. This measure resulted in an anterior arch length. Then the posterior arch length was measured from the vertical line which was the distance from the middle of the central incisors perpendicular to the line formed between the tips of the mesiobuccal cusps of the right and left first molars. Anterior dental arch width was measured from the inter-canine width, and posterior dental arch width was measured from the inter-molar width. Inter-canine width was measured from the cusp tip of one side to the cusp tip of the other side for each canine, and inter-molar width was taken from the mesiobuccal cusp tip of the right side to the left side. These measurements were done in both arches. All measurements and assessments of all required parameters were carried out by one operator to reduce the error measurement. The study models were assessed twice, and individual measurements that differed by more than 0.1 mm were measured a third time to resolve the discrepancy. The data were analysed by Pearson's correlation to find the correlation between age and dental arch dimension (Figure 1) of Javanese Indonesian children in good nutritional status.

Dental Journal (Majalah Kedokteran Gigi) p-ISSN: 1978-3728; e-ISSN: 2442-9740. Accredited No. 32a/E/KPT/2017.

DOI: 10.20473/j.djmkg.v53.i2.p93–98

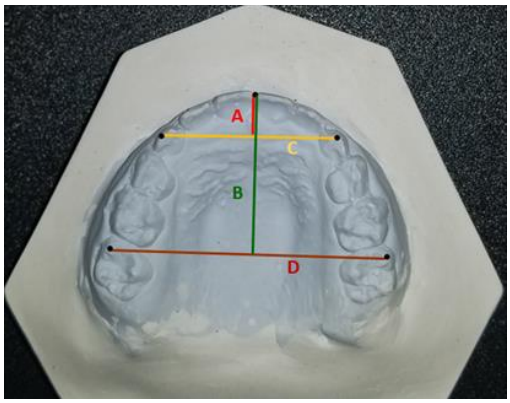

Figure 1. Dental arch dimension. Anterior dental arch length (A); posterior dental arch length (B); anterior dental arch width (C); posterior dental arch width (D).

RESULTS

The study of the correlation between age and dental arch dimension of Javanese Indonesian children aged 8–10 years old was done by measuring both maxillary and mandibular anterior and posterior length and width of the dental arch, and the data were analysed by Pearson's correlation. The descriptive statistics (mean, standard deviation) of anterior and posterior dental arch length and width in maxilla and mandible are shown in Table 1. The mean of the maxillary anterior and posterior dental arch length increases in all of the age groups (Table 1), and correlation analysis shows that there were significant weak correlations between age and both maxillary anterior dental arch length ($p = 0.011$; $r = 0.31$) and posterior dental arch length ($p = 0.043$; $r = 0.249$) (Table 2). The mean of the maxillary anterior dental

Table 1. Mean ± SD maxillary and mandibular dental arch length and width in 8–10-year-old Javanese children

Age (years)	Maxillary dental arch				Mandibular dental arch			
	length (cm)		width (cm)		length (cm)		width (cm)	
	anterior	posterior	anterior	posterior	anterior	posterior	anterior	posterior
8	7.17 ± 1.10	29.88 ± 1.94	33.34 ± 2.34	52.23 ± 2.08	4.03 ± 1.03	24.95 ± 2.14	27.32 ± 2.09	46.46 ± 1.96
9	7.37 ± 1.26	30.22 ± 2.27	32.74 ± 1.76	52.81 ± 2.31	4.51 ± 1.04	24.77 ± 2.75	26.28 ± 2.09	45.69 ± 1.97
10	8.08 ± 1.20	31.67 ±3.47	34.23 ± 1.65	53.40 ± 2.37	4.49 ± 1.21	25.12 ± 1.76	26.95 ± 1.75	46.03 ± 2.47

Table 2. Correlation between age and maxillary dental arch length

		Maxillary anterior dental arch length	Maxillary posterior dental arch length	Age
Maxillary anterior dental arch length	Coefficient correlation	1	0.578	0.310
	Sig. (2-tailed)		0.000	0.011
	N	66	66	66
Maxillary posterior dental arch length	Coefficient correlation	0.578	1	0.249
	Sig. (2-tailed)	0.000		0.043
	N	66	66	66
Age	Coefficient correlation	0.310	0.249	1
	Sig. (2-tailed)	0.011	0.043	
	N	66	66	66

Table 3. Correlation between age and maxillary dental arch width

		Maxillary anterior dental arch width	Maxillary posterior dental arch width	Age
Maxillary anterior dental arch width	Pearson correlation	1	0.369	0.187
	Sig. (2-tailed)		0.002	0.133
	N	66	66	66
Maxillary posterior dental arch width	Pearson correlation	0.369	1	0.211
	Sig. (2-tailed)	0.002		0.089
	N	66	66	66
Age	Pearson correlation	0.187	0.211	1
	Sig. (2-tailed)	0.133	0.089	
	N	66	66	66

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DOI: 10.20473/j.djmkg.v53.i2.p93–98

arch width increased from the age of 8 years old to 10 years old, and it happened in the posterior too (Table 1). There was a significant correlation between maxillary anterior and maxillary posterior dental arch width ($p = 0.002$; $r = 0.37$), but neither maxillary anterior nor maxillary posterior dental arch width had a significant correlation with age (Table 3).

The mean of the mandibular anterior dental arch length increases from the age of 8 to 10 years old, and this happens in the posterior from 8 to 10 years old too, but there were decreases in both mandibular anterior and posterior dental arch width. A significant correlation between mandibular anterior and posterior dental arch length ($p = 0.024$; $r = 0.277$) could be seen in Table 4, and significant correlation between mandibular anterior and posterior dental arch width ($p = 0.014$; $r = 0.301$) could be seen in Table 5. Table 5 also showed that there was a negative value for Pearson's correlation coefficient between the mandibular anterior ($r = -0.075$) and posterior ($r = -0.082$) dental arch width and age, but $p > 0.05$, which indicated that the correlations were not significant.

DISCUSSION

The development of the dental arch is a continuous process with some changes during the mixed developmental period. The results of this study showed that there were differences in the length and width of the dental arch between children aged 8, 9, and 10 years. Table 1 showed that there was an increase of anterior and posterior dental arch length, both in maxilla and mandible. These results are in accordance with Bisara et al.'s study, which stated that in children aged from 3–13 years old, maxillary arch length increased significantly, and on the other hand the increase in mandibular arch length was complete by 8 years.[20] Table 2 showed a correlation between maxillary anterior and posterior dental arch length ($p < 0.05$; $r = 0.578$). This table also showed that there were correlations between age and both maxillary anterior and posterior dental arch length.

The correlation coefficient has a positive value; which indicates a relationship between two variables in which both variables move in the same direction. When the ages increase, the maxillary dental arch length will increase too. This increase in the size of the dental arch is due to the change at this age of deciduous teeth into permanent teeth, which take a larger dental arch; this is caused by the mesiodistal size of the permanent teeth being larger than the mesiodistal size of deciduous teeth. It was supported by Foster[21], who states that the mesiodistal size of permanent teeth is larger than the mesiodistal size of primary teeth. The length of the maxillary anterior dental arch increases due to the eruption of permanent anterior teeth. The age of 8–10 years is the age of maxillary lateral incisor eruption, which affects the increase in the arch size of the anterior teeth.

Table 5. Correlation between age and mandibular dental arch width

		Mandibular anterior dental arch width	Mandibular posterior dental arch width	Age
Mandibular anterior dental arch width	Pearson correlation	1	0.301	−0.075
	Sig. (2-tailed)		0.014	0.551
	N	66	66	66
Mandibular posterior dental arch width	Pearson correlation	0.301	1	−0.082
	Sig. (2-tailed)	0.014		0.512
	N	66	66	66
Age	Pearson correlation	−0.075	−0.082	1
	Sig. (2-tailed)	0.551	0.512	
	N	66	66	66

Table 4. Correlation between age and mandibular dental arch length

		Mandibular anterior dental arch length	Mandibular posterior dental arch length	Age
Mandibular anterior dental arch length	Pearson correlation	1	0.277	0.170
	Sig. (2-tailed)		0.024	0.172
	N	66	66	66
Mandibular posterior dental arch length	Pearson correlation	0.277	1	0.030
	Sig. (2-tailed)	0.024		0.813
	N	66	66	66
Age	Pearson correlation	0.170	0.030	1
	Sig. (2-tailed)	0.072	0.813	
	N	66	66	66

Dental Journal (Majalah Kedokteran Gigi) p-ISSN: 1978-3728; e-ISSN: 2442-9740. Accredited No. 32a/E/KPT/2017.

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This is supported by previous research conducted by Ogodescu et al., which states that the eruption of permanent central incisors, permanent lateral incisors, and permanent canines can cause the increase of anterior dental arch length.[22] These results are in accordance with the study of Thilander, which states that there were some increases in the length of the anterior and posterior mandibular dental arch and that these could be caused by the change of primary canines into permanent canines since the mesiodistal permanent canine is larger than the primary canine, and due to the eruption of incisor teeth in a proclined position.[13] In children aged 8 years old, there were deciduous canine teeth that were smaller in size than permanent canine teeth. At the age of 9 years old the mandibular permanent canines have erupted and moved rapidly, so the average inter-canine distance increases at this age due to the size of the permanent teeth being larger than the primary canines.[8] The mean of the mandibular anterior dental arch length increases with age between 8 and 10 years old, and it happens in the posterior from 8 to 10 years old too. A significant correlation between mandibular anterior and posterior dental arch length ($p = 0.024$; $r = 0.277$) could be seen in Table 4.

The maxillary anterior and posterior arch width were increased at these ages (Table 1). These conditions were in accordance with the results of the study by Thilander, which states that in the maxilla there was an increase of arch width recorded up to 16 years of age, especially between 5 and 10 years.[13] These results are also consistent with Heikinheimo et al.'s research, which stated that the maxillary canine width increased from 7 to 12 years, and the increase continued up to the age of 15.[23] These might have occurred due to the size differences of deciduous and permanent canines.[24] This study showed that there was a correlation between maxillary anterior and posterior dental arch width ($p = 0.002$; $r = 0.37$), but neither maxillary anterior nor maxillary posterior dental arch width had a significant correlation with age (Table 3). This result is in accordance with the study of Skripsa el al. which stated that there was a significant relationship between inter-canine and inter-molar width.[25]

The mandibular anterior and posterior arch width decreased with age between 8 and 10 years (Table 1). These were in line with the result of Sinclair et al.'s research, as cited by Loulyi et al., that found a decrease in mandibular inter-canine width between mixed and early permanent dentitions.[26] This result accords with the study of Thilander, which states that the permanent first mandibular molars will drift mesially, resulting in a decrease in the depth and width of the dental arch.[13] A significant correlation between mandibular anterior and posterior dental arch width ($p = 0.014$; $r = 0.301$) could be seen in Table 5. This relationship was supported by the result of research from Skripsa et al. that said that inter-canine and inter-molar widths exhibited a significant relationship.[25] Table 5 showed that the Pearson's correlation coefficient between mandibular anterior and posterior dental arch width and age had negative values. It means that there was an inverse correlation between those variables, whereby they moved in opposite directions: when the ages increase, then the mandibular dental arch width decreases. But the value of $p > 0.05$; this indicated that the correlations were not significant. Neither mandibular anterior nor posterior dental arch width had significant correlation with age. In Louly's study, there was a non-significant slight increase for the maxillary inter-canine width and a decrease for the mandibular inter-canine width. These differences could be related to genetic or ethnic variations.[26] Based on the result of this study, it can be concluded that there was a positive correlation between age and dental arch dimension of Javanese children in good nutritional status. This relation is especially in maxillary dental arch length, and it was in a weak correlation.

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