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The dental arch dimensions in Vietnamese children at 7 years of age, and their variation by gender and ethnicity

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ABSTRACT

Purpose: Dental arch dimensions are important not only in dentistry (e.g. orthodontists and prosthodontists, and forensic odontology), but also other medical fields, biology, biometrics, painting or sculpture. This study aimed to determine these dimensions in Vietnamese children and compare these measurements across four ethnic groups and genders.

Methods: A cross-sectional study was conducted on 3204 Vietnamese children at 7 years of age from four major ethnic groups in Vietnam (Kinh, Tay, Thai and Muong).

Results: The means variables in study subjects were 33.72 ± 2.16 mm for upper inter-canine width (UCW); 52.74 ± 2.55 mm for upper inter-molar width (UMW); 8.69 ± 1.79 mm for upper anterior length (UAL); 29.59 ± 1.97 mm for upper posterior length (UPL); 26.94 ± 2.49 mm for lower inter-canine width (LCW); 45.89 ± 2.59 mm for lower inter-molar width (LMW); 5.04 ± 1.53 mm for lower anterior length (LAL); and 26.22 ± 2.07 mm for lower posterior length (LPL). The UCM, UMW, and LMW of Muong were significantly wider in males, but narrower in females compared with other ethnic groups. The Kinh, Tay and Thai groups had no significant differences between genders in all dimensions, but these sizes were significantly larger in males than females of Muong group.

Conclusions: This study presents the means of dental arch dimensions in 7 year-old Vietnamese children, and there is no statistical differences in these dimensions between genders of almost studied groups, except Muong group. Ethnic differences are observed only in UCW, UMW and LMW of Muong vs other groups. Furthermore, Vietnamese children have dental arch width similar to the African and Caucasian.

1. Introduction

In clinical settings, dental arch dimensions are very important for both orthodontists and prosthodontists.[1] In anthropometry, dental casts can be studied directly or indirectly. The direct researches involve manually measurements of arch sizes. The dissonance between tooth size and arch size leads to improper alignment and malocclusion. One of the most frequent occurring malocclusion is crowding and which is usually a result of the discrepancy among the volume of alveolar bone, dental arch dimensions and tooth sizes.[2] Some groups have defined these dimensions and proved correlations between these measurements and the craniofacial discrepancies with crowding teeth and

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Table 1
Symbols and definitions of measured arch dimensions.

Arch dimension	Acronym	Definition
Upper inter-canine width	UCW	Distance between two cusp tips of left and right maxillary deciduous canines of dental arch
Upper inter-molar width	UMW	Distance between two mesiolabial cusp tips of the right and left maxillary permanent molars
Upper anterior length	UAL	Distance between centric point of upper incisal papilla to a horizontal line drawn between left and right cusp tips
Upper posterior length	UPL	Distance from centric point of upper incisal papilla to a horizontal line drawn along the distal margins of the left and right first permanent molars
Lower inter-canine width	LCW	Distance between two cusp tips of left and right mandibular deciduous canines of dental arch
Lower inter-molar width	LMW	Distance between two mesiolabial cusp tips of the right and left mandibular permanent molars
Lower anterior length	LAL	Distance from centric point of lower incisal papilla to a horizontal line drawn between left and right cusp tips
Lower posterior length	LPL	Distance from centric point of lower incisal papilla to a horizontal line drawn along the distal margins of the left and right first permanent molars

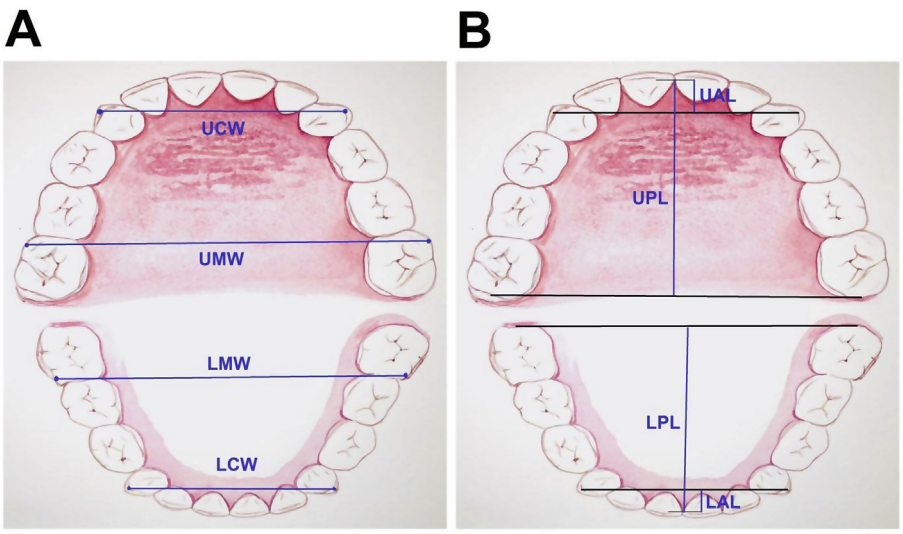

Fig. 1. Arch width (A) and length (B) on dental cast.

Table 2
The distribution of the sample by sex for the four ethnic groups in previous study.

Ethnic groups	Sex				Total	
	Male		Female			
	n	%	n	%	n	%
Kinh	942	29.40	769	24.00	1711	53.40
Tay	255	7.96	234	7.30	489	15.26
Thai	252	7.87	254	7.93	506	15.80
Muong	265	8.27	233	7.27	498	15.54
Total	1714	53.50	1490	46.50	3204	100

malocclusion in patient group of 7 years children in the American and Kenyan population.[3–6] The width dimensions significantly increased from 3 to 13 years of age in both bimaxillary arches. The size of the dental arch was found to be almost unchanged or slightly decreased after the eruption of permanent teeth.[7] The width and length dimensions of dental arch are established in children at the period of mixed dentition; this life period has most orthodontic treatments. Therefore it is essential for the doctor to consider the overall change and accurately measure arch dimensions of 7-year-old children during early orthodontic treatment.[8]

Mixed dentition analyses with dental arch dimensions were created to predict the amount of space available in the arch for succeeding permanent teeth and necessary occlusal adjustments. Previous researches on dental arch dimensions were performed only on the Caucasian and African populations; there has been no data available on Southeast Asian population. In clinics, the ethnic variation in arch dimensions should be considered during intervention, especially in early orthodontic treatment.[9]

Vietnam is a country in Southeast Asian area with 54 ethnic groups and has the population of approximately 90 million people [101010]. Among these ethnic groups, Kinh, Thai, Tay and Muong are the majority, account for 91% of total Vietnamese population (according to a national census of the population in 2009) [101010]. Therefore, this study was conducted in the child population (7-years) of four major ethnic groups.

In this study, we have determined the mean values of dental arch dimensions in 7 year-old Vietnamese children and compared these parameters by genders and ethnic groups (Kinh, Muong, Thai and Tay). We found that there was no statistical differences in these dimensions between genders of almost studied groups, except Muong group. Ethnic differences are observed only in UCW, UMW and LMW of Muong vs other groups. Besides, we also found that Vietnamese children had dental arch width similar to the African and Caucasian at the same age. These results are useful for orthodontists and prosthodontists in children, and the parameters used in the study may be proposed as useful in forensic identifications in future.

2. Materials and methods

We applied a formula (Formula of WHO sample size determination in Health studies, 2.0) to calculate the sample size in this cross –sectional study as:

$$n = Z^2 1 - \alpha/2 \frac{SD^2}{(\bar{X} \cdot \varepsilon)}$$

Table 3
Comparison of dental arch dimensions in four ethnic groups between two genders.

Variable (mm)	Kinh ethnic			Tay ethnic			Thai ethnic			Muong ethnic			Total group		
	M n = 942 Mean ± SEM	F n = 769 Mean ± SEM	p	M n = 255 Mean ± SEM	F n = 234 Mean ± SEM	p	M n = 252 Mean ± SEM	F n = 254 Mean ± SEM	p	M n = 265 Mean ± SEM	F n = 233 Mean ± SEM	p	M n = 1714 Mean ± SEM	F n = 1490 Mean ± SEM	p
UCW	33.79 ± 2.12	33.64 ± 2.22	**NS**	33.75 ± 2.22	33.66 ± 2.08	**NS**	33.68 ± 2.25	33.75 ± 2.04	**NS**	34.14 ± 2.04	33.22 ± 2.16	***	33.82 ± 2.15	33.6 ± 2.16	***
UMW	52.76 ± 2.56	52.7 ± 2.53	**NS**	52.75 ± 2.59	52.74 ± 2.53	**NS**	52.86 ± 2.51	52.68 ± 2.64	**NS**	53.23 ± 2.49	52.18 ± 2.51	***	52.85 ± 2.55	52.62 ± 2.55	***
UAL	8.65 ± 1.87	8.71 ± 1.69	**NS**	8.86 ± 1.95	8.51 ± 1.57	**NS**	8.62 ± 1.69	8.76 ± 1.87	**NS**	8.77 ± 1.91	8.6 ± 1.65	**NS**	8.7 ± 1.86	8.67 ± 1.7	**NS**
UPL	29.6 ± 1.98	29.58 ± 1.94	**NS**	29.61 ± 2	29.58 ± 1.95	**NS**	29.54 ± 1.94	29.68 ± 2	**NS**	29.73 ± 1.9	29.44 ± 2.05	**NS**	29.61 ± 1.96	29.58 ± 1.97	**NS**
LCW	26.95 ± 2.49	26.92 ± 2.5	**NS**	27.02 ± 2.42	26.89 ± 2.58	**NS**	26.94 ± 2.59	26.97 ± 2.38	**NS**	27.14 ± 2.46	26.72 ± 2.5	**NS**	26.99 ± 2.49	26.89 ± 2.49	**NS**
LMW	45.85 ± 2.53	45.94 ± 2.66	**NS**	45.94 ± 2.68	45.85 ± 2.5	**NS**	46.03 ± 2.66	45.79 ± 2.53	**NS**	46.46 ± 2.65	45.24 ± 2.36	***	45.98 ± 2.6	45.79 ± 2.58	*
LAL	5.02 ± 1.45	5.06 ± 1.66	**NS**	4.95 ± 1.37	5.11 ± 1.59	**NS**	5.05 ± 1.59	5.04 ± 1.47	**NS**	5.07 ± 1.36	5.01 ± 1.72	**NS**	5.02 ± 1.45	5.06 ± 1.63	**NS**
LPL	26.19 ± 2.08	26.24 ± 2.07	**NS**	26.17 ± 2.1	26.27 ± 2.06	**NS**	26.11 ± 2.05	26.33 ± 2.09	**NS**	26.39 ± 1.99	26.04 ± 2.14	**NS**	26.2 ± 2.07	26.23 ± 2.08	**NS**

P form *t*-test for comparing two genders with each ethnic population.

n: minimum sample size for each ethnic nation.
$Z_{1-\alpha/2}$: Reliable coefficient, with a reliability of 95%, Z = 1.96.
SD: Standard deviation.
$\overline{X}$: Average mean.
Ɛ: Relative deviation between sample and population, selected Ɛ = 0.01.

According to research result of Hassanali et al. (2000)[6], inter canine distance of mandibular (CC2 in female) of Kenyan children at 6–8 years old: $\overline{X}$ ± SD: 2.66 ± 0.24 mm.

Instead of formula:
n = 313 children

With four ethnic nations, N = 4 x n = 4 × 312 = 1252, but in fact we selected 3204 Vietnamese Children at 7-year-old out of 5318 children, the studied subjects were randomly selected from four major ethnic groups (Kinh, Tay, Thai, and Muong) in Vietnam during 2016–2017. There were 1.3 million children at 7 years of age in Vietnam, distributed extensively within 54 ethnic populations and but concentrated in four major nations: Kinh (85.73%), Tay (1.90%), Thai (1.81%) and Muong (1.48%).[10]

The selection criteria for this study required that subjects had all permanent first molars, four erupted incisors, all deciduous, first and second premolars and canines. The exclusive criteria include history of orthodontic treatment, history of dental trauma, evidence of syndromes or craniofacial malformations and obvious facial asymmetry. Teeth those were examined need to be carious, missing, hypoplastic, restored at the measured landmarks, worn and malformed, or orthodontically treated were not included in the study. Alginate impressions (Aroma fine plus normal set, GC Corp, Tokyo, Japan) were poured in orthodontic plaster (New Plastone II, GC Corp, Tokyo, Japan) for 4–6 h. Sliding dial calipers (Mitutoyo Manufacturing Co. Ltd, Kawasaki, Japan), to accurately measured within ± 0,01 mm, were employed to determine all manual measurements.

The measurements of arch dimensions were recorded by the group of five dentists. The group had been trained to measure dental cast carefully and utilized the same guidelines each time. The average of double measurements was made by each dentist to estimate the intra-observer agreement. Analysis of intra-observer reproducibility showed almost perfect agreement with all the measurements by each of the five dentists (Intraclass Correlation Coefficient - ICC > 0.9 in each instance and high correlation on Bland-Atlman plots). The ICCs value in this study were between 0.9 and 0.99 and had the high Pearson Correlation Coefficient (PCC) (r > 0.9). These data showed in the pilot study indicates a strong agreement between the two separately repeated measurements made by five dentists with thirty randomly selected casts. The method error was within 0.1 mm for all parameters, which was in line with previous investigations.[1,3,7–9]

The collected data were checked and analyzed by using statistical program SPSS (version 23.0, SPSS Inc., Chicago).[11,12] All variables were in a normal distribution with Kolmogorov-Smirnov test and normal quantile plots (data no shown). The two independent samples were analyzed using student's T-test, while multiple samples were analyzed using one-way ANOVA. Data were presented as the mean ± standard error of the mean (SEM). The P-value was considered as statistical significance if P < 0.05 with *P < 0.05, **P < 0.01, and ***P < 0.001; and not significant (n.s) if P > 0.05. The definition and symbols of studied arch dimensions were shown in Table 1 and Fig. 1.

3. Results

The study design includes 3204 Vietnamese children cohort from 4 major ethnic groups (Kinh, Tay, Thai, and Muong) at the age of 7 years (1714 boys (53.50%) and 1490 girls (46.50%) (Table 1). The percentages of four ethnic groups were presented in Table 2. The Kinh group

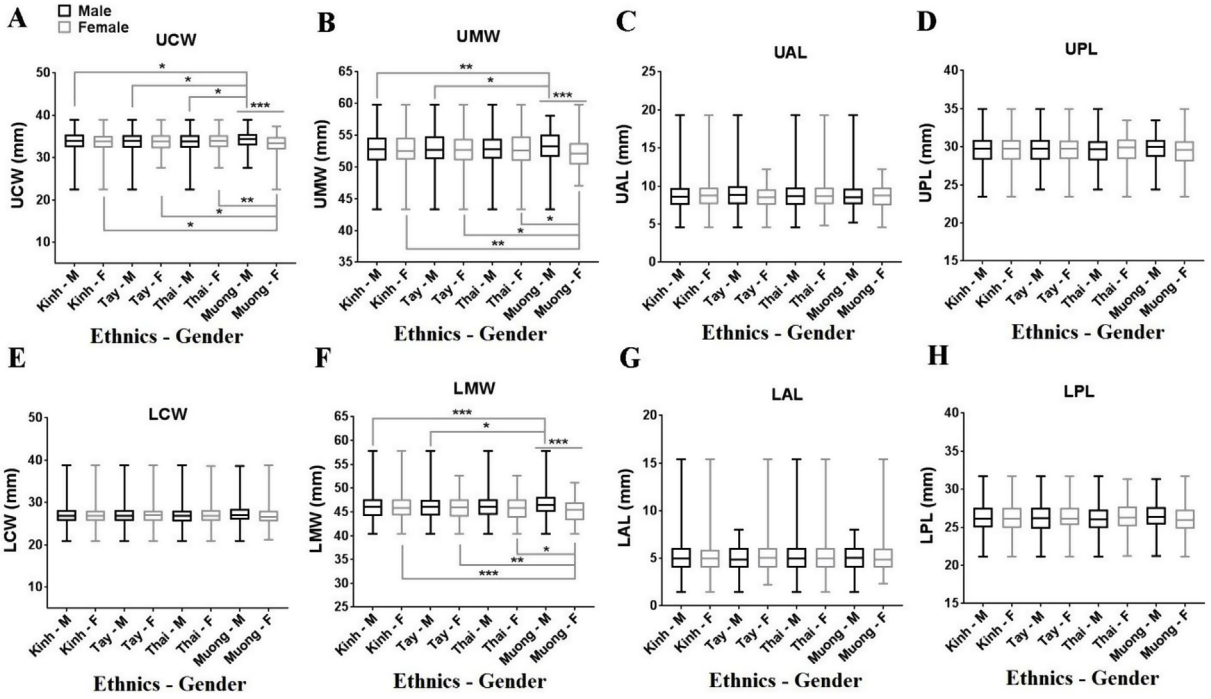

Fig. 2. Dental arch dimensions in Vietnamese Children at 7 years of age. Ethnic and gender comparisons of UCW (A), UMW (B), UAL (C), UPL (D), LCW (C), LMW (F), LAL (G) and LPL (H).

Table 4
Difference of dental arch dimensions according to four ethnic groups in male subjects.

Variable (mm)	Kinh ethnic n = 942 Mean ± SEM	Tay ethnic n = 255 Mean ± SEM	Thai ethnic n = 252 Mean ± SEM	Muong ethnic n = 265 Mean ± SEM	p
UCW	33.79 ± 2.12	33.75 ± 2.22	33.68 ± 2.25	34.14 ± 2.04	*
UMW	52.76 ± 2.56	52.75 ± 2.59	52.86 ± 2.51	53.23 ± 2.49	*
UAL	8.65 ± 1.87	8.86 ± 1.95	8.62 ± 1.69	8.77 ± 1.91	NS
UPL	29.6 ± 1.98	29.61 ± 2	29.54 ± 1.94	29.73 ± 1.9	NS
LCW	26.95 ± 2.49	27.02 ± 2.42	26.94 ± 2.59	27.14 ± 2.46	NS
LMW	45.85 ± 2.53	45.94 ± 2.68	46.03 ± 2.66	46.46 ± 2.65	**
LAL	5.02 ± 1.45	4.95 ± 1.37	5.05 ± 1.59	5.07 ± 1.36	NS
LPL	26.19 ± 2.08	26.17 ± 2.1	26.11 ± 2.05	26.39 ± 1.99	NS

Table 5
Difference of dental arch dimensions according to four ethnic groups in female subjects.

Variable (mm)	Kinh ethnic n = 769 Mean ± SEM	Tay ethnic n = 234 Mean ± SEM	Thai ethnic n = 254 Mean ± SEM	Muong ethnic n = 233 Mean ± SEM	p
UCW	33.64 ± 2.22	33.66 ± 2.08	33.75 ± 2.04	33.22 ± 2.16	*
UMW	52.7 ± 2.53	52.74 ± 2.53	52.68 ± 2.64	52.18 ± 2.51	*
UAL	8.71 ± 1.69	8.51 ± 1.57	8.76 ± 1.87	8.6 ± 1.65	NS
UPL	29.58 ± 1.94	29.58 ± 1.95	29.68 ± 2	29.44 ± 2.05	NS
LCW	26.92 ± 2.5	26.89 ± 2.58	26.97 ± 2.38	26.72 ± 2.5	NS
LMW	45.94 ± 2.66	45.85 ± 2.5	45.79 ± 2.53	45.24 ± 2.36	**
LAL	5.06 ± 1.66	5.11 ± 1.59	5.04 ± 1.47	5.01 ± 1.72	NS
LPL	26.24 ± 2.07	26.27 ± 2.06	26.33 ± 2.09	26.04 ± 2.14	NS

accounted for the largest population with 50.43%.

Most of dental arch dimensions were not significantly different between two genders (Table 3, and Fig. 2). Among arch dimensions, UCW, UMW, and LMW were significantly different between two genders of Muong ethnic and in combined groups ($p < 0.001$, Table 3 and Fig. 2A, B and F). These dimensions were larger in males compared to females of the Muong group.

Most measurements were not significantly different among four ethnics groups adjusted by gender (Tables 3 and 5 and Fig. 2). There were the ethnic differences observed in UCW, UMW and LMW in both males and females in this study ($p < 0.05$). Accordingly, Muong males had the largest UCW, UMW, and LMW as 34.14 ± 2.04, 53.23 ± 2.49, and 46.46 ± 2.65 (mm) respectively (Table 4). In contrast, Muong females had shortest UCW, UMW and LMW as 33.22 ± 2.16, 52.18 ± 2.51 and 45.24 ± 2.36 (mm), respectively (Table 5).

4. Discussion

The percentage of Kinh ethnic was entirely superior with 53.40% compared to other populations (Table 2), this goes according to demographic model in Vietnam (the national census of the population in 2009) [10101010][10]. The mean variables were not significantly changed between two genders in most ethnical groups. The changes were observed only in male vs females in Muong group. These results were not similar to studies performed by Hassanali et al. in Kenyan population[6] and Sarhan et al. in Egyptian and British populations.[13] This finding indicates that people with different origins have diversity in the dental arch in agreement with the vital environment. According to one study by Sillmann et al.,[14] the sizes of dental arch from birth to 25 years changed rapidly from 5 to 7 years and 11–13 years during period of tooth eruption (from deciduous to permanent teeth). However, as there was a historic origin among four ethnic populations, the trend of growth and changes in dental arch measurements would be different. The factors accounting for this difference could be vital environment, nutritional conditions, social economy and functional factors (such as masticating, swallowing or respiration).[14–16]

When we compared the dental arch dimensions between our study and the study done by Hassanali et al., the UCW, UMW, and LCW in Vietnamese children were not significantly different from Kenyan children. However, UPL, LML, and LPL in Kenyan children were larger in comparison to those in Vietnamese children ($p < 0.001$, Table S1).[6] The small dental arch dimensions (UPL, LPL) could result at a higher rate of dental discrepancy in Vietnamese children.[17] The sample size in Kenyan study was small (97 children) and the range of age was large

(from 6 to 8 years old). On the other hand, we analyzed our data on larger sample size (3204 children) and range of age was from 6 years 10 months to 7 years 2 months (mean of age was 7 years 1 month).

Furthermore, LAL in our population was larger than in the subjects analyzed by Ross- Powell RE et al. in both genders; while UAL in female in their report was larger than in our study ($p < 0.001$, Table S2). Significant changes were observed between Vietnamese and black American children (two anthropometric populations). A noteworthy characteristic between Vietnamese and black American children was changes in anterio-posterior dental arch dimensions (Tables S1 and S2). Analysis of dental arch dimensions in shown in this study was in agreement with the results of other studies and these measurements were not similar to the ethnic populations with different anthropometry of origin.[18–21]

5. Conclusions

The eight dental arch dimensions on the cast in 3204 Vietnamese children from 4 ethnic groups (Kinh, Tay, Thai, and Muong) were not significantly different between males and females with an exception of the Muong ethnic group. Ethnic differences of maxillary and mandibular width were observed among four populations in each gender, especially in Muong vs other ethnic groups. The Vietnamese had the measurements of width similar to the African and the Caucasian (the black American); the noteworthy characteristic was these major differences of anterio-posterior dental arch dimensions (length) between Vietnamese children and others.

Ethical statement

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This study was a part of national project entitled “Vietnamese Characteristics of Craniofacial anthropometry to apply in medicine” approved by Hanoi Medical Council of ethics in biomedical research in 2016, IRB code - VN01001.

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Conflict of interest statement

All authors have no conflicts of interest or financial ties to disclose.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jobcr.2019.06.004.

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