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Original Article

THE MAXILLARY ARCH AND CEPHALOMETRIC MEASUREMENTS: COMPARING ETHNIC MALAYS AND ETHNIC CHINESE IN MALAYSIA

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ABSTRACT

A cross-sectional study was conducted to compare maxillary arch and head measurements between ethnic Malays and Chinese. Mean ages were 23.5 years (Malay) and 21.1 years (Chinese), and both groups were brachycephalic with the cephalic index 86.4 for Malay and 85.9 for Chinese which is not significantly different between them. Means of anterior arch width (AAW), posterior-arch-width (PAW) and arch-length were significantly different between two groups. AAW and PAW were significantly different from their corresponding indices for Malays but not for Chinese. The Pont's and Korkhaus' Indices could not be applied to the Malays but moderately to the Chinese.

KEY WORDS: Dental Arch, Cephalometric Index, Ethnic Malay, Chinese, Pont's and Korkhaus's Indices.

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INTRODUCTION

A correct knowledge of tooth size and dental arch dimensions of a population are important for several dental treatment procedures. In Restorative Dentistry, restoration of normal morphology of a tooth depends on the knowledge of correct dimensions of the teeth. There are heritable differences in dental arch and head dimensions of different populations. These heritable differences are useful for the practice of Aesthetic Dentistry and for effective orthodontic treatment [1]. It is therefore important to have knowledge of certain cephalometric and dental arch parameters and their relationships for a given population. There are several indices derived from these measurements and indices of Pont [2], Linder [3] and Korkhaus [4] are mostly used in German-speaking countries [5]. These measurements permit a crude analysis of the anteroposterior position of incisors. The cephalic index (CI) - the ratio between the width and length of the head - has been used to classify people as having one of the three characteristic head shapes namely dolichocephalic (CI <74.9%) or mesocephalic (75-79.9%) or brachycephalic (CI 80-84.9%) [6].

The objectives of this study were to compare dental arch indices, cephalometric measurements between ethnic Malays and Chinese; and to observe the correlation, and to validate the dental arch indices in the study population.

MATERIALS AND METHODS

Bootstrap statistics [7] based on 1000 simulated means of the sum of four upper incisors (SI_U)

estimated a standard deviation (SD) of 2.3mm. This SD was used to calculate a sample of 80 adult Malays and Chinese, required estimating SI_U with a precision of +/- 0.5 mm at 95% confidence interval.

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Preliminary screening procedures were conducted among students from Teachers Training College, Kota Bharu and Phase 1 and Phase 2 students from Schools of Medical Sciences and Dental Sciences of Universiti Sains Malaysia. Inclusion Criteria were

ages between 20 and 35 years, parents and grand parents from both paternal and maternal sides being Malay or Chinese. Subjects with upper dental arch irregularities, missing teeth and those whose next-of-kin already being selected were excluded. Among those eligible, were 90 Malays and 90 Chinese students. After a brief self-administered questionnaire session, head measurements and maxillary dental arch casts were taken.

The head measurements made on the subjects were:

(i) maximum skull length (g-op), distance from external occipital protruberance to glabella; (Fig-1a).

(ii) maximum skull breadth or bieuryonic width, (eu_eu), distance between the most lateral points of the skull; (Fig-1b).

(iii) bizygomatic width (zy_zy), distance between two zygomatic prominences; (Fig-1b)

The measurements performed on the maxillary dental arch casts included:

(i) Sum of mesiodistal size of four upper incisors (SIu).

(ii) Anterior arch width (AAW) that is the distance between the lower-most points of the transverse fissure of the upper first premolar teeth (the reference points for (AAW).

(iii) Posterior arch width (PAW), the distance between the points of intersection of the transverse fissure with the buccal fissure of the upper first permanent molar teeth (the reference points for PAW).

Fig. 1a: Maximum skull length (g-op), distance from external occipital protruberance (op) to glabella (g).

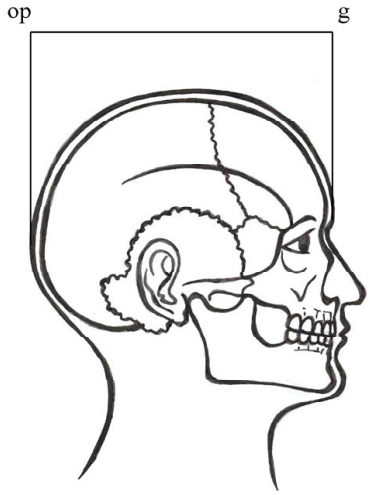
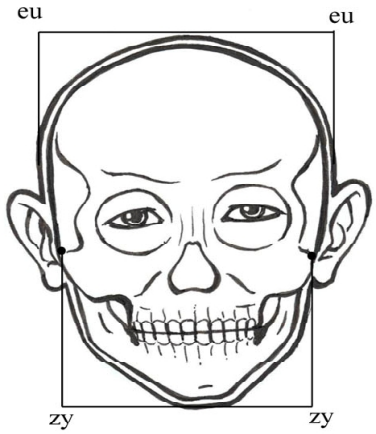
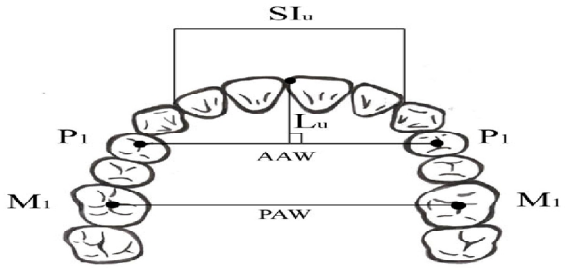


Fig- 1b: Maximum skull breadth or bieuryonic width, (eu_eu), distance between the most lateral points of the skull.



Bizygomatic width (zy_zy), distance between the two zygomatic prominences.

Fig. 2: Anterior arch width (AAW) that is the distance between the lower-most points of the transverse fissure of the upper first premolar teeth (the reference points for (AAW).



Posterior arch width (PAW), the distance between the point of intersection of the transverse fissure with the buccal fissure of the upper first permanent molar teeth (the reference points for PAW).

Anterior arch length Lu, which is perpendicular from the most anterior labial surface of the central incisors to the connecting line of the reference points of AAW.

All measurements were in millimeters to the nearest 0.1 mm.

(iv) Anterior arch length Lu, which is perpendicular from the most anterior labial surface of the central incisors to the connecting line of the reference points of AAW. All measurements were in millimeters to the nearest 0.1 mm.

All measurements of casts are shown in Fig-2.

Data Analysis: STATA 7.0 [8] was used to summarize the data and validate the indices using uni- and multi-variable statistical methods. Three Malays and one Chinese were excluded because of poor impressions on the casts. From the measurements made on dental casts, the sum of upper incisor mesiodistal distances (SIu) was first computed and this measure was used to estimate the values of Pont's Indices and Korkhaus' Index by:

formulae: Pont's Index, $\frac{SI_u}{85}\times 100$ for AAW

and $\frac{SI_u}{65}\times 100$ for PAW)

Korkhaus' Index, $L_u = \frac{SI_u}{160}\times 100$

These index values thus estimated were then validated against the actual measurements made on the casts. Cephalic Index (CI) was calculated by taking the ratio between maximum skull breadth (eu_eu) and maximum skull length (g_op). CI values were expressed in percents. Independent t and paired t tests were used as appropriate to compare all these measurements and indices between ethnic groups. Eight separate analyses of covariance (ANCOVA) were performed to compare age-sex adjusted means of each head or (DAM) Dental Arch Measurements between two ethnic groups. These results were summarized and the significance level of all statistical tests was set at p-value < 0.05.

RESULTS

Ethnic group	Gender				Total	
	Male		Female			
	No.	%	No.	%	No.	%
Malay	28	32.18	59	67.82	87	100
Chinese	51	57.3	38	42.7	89	100
Total	79	44.89	97	55.11	176	100

Table 1: Distribution of the study population by ethnicity and gender.

Table 2. Distribution and comparison of actual values of Maxillary Arch measurements in mm between sex groups and ethnic groups.

Dental arch measurements (DAM) of Maxilla	Male (n = 80)		Female (n = 98)		Mean difference (male-female)	P-value t-test
	Mean	SD	Mean	SD		
AAW	37.32	2.39	36.04	3.24	1.28	0.004
PAW	49.58	2.88	47.26	4.41	2.32	0.01
Lu	18.16	2.31	17.87	2.11	0.29	0.379
SIu	32.33	1.86	31.91	2.09	0.41	0.179
Dental arch measurements (DAM) of Maxilla	**Ethnic Malay n=86**		**Ethnic Chinese n=89**		**Mean difference (Chinese– Malay)**	**P-value t-test**
	Mean	SD	Mean	SD		
AAW	35.54	3.25	37.6	2.36	2.06	0.001
PAW	47.31	5.72	48.95	3.15	1.64	0.029
Lu	17.99	3.69	18.28	2.01	0.29	0.09
SIu	32.06	2.31	32.13	1.75	0.07	**0.816**

SIu = sum of four upper incisors
AAW = anterior arch width measured from the cast
PAW = posterior arch width measured from the cast
Lu = arch length measured from the cast

DAM	Adjusted Mean (95% CI) in mm	F statistics (df)	P-value
Slu			
Malay	31.98 (31.482, 32.482)	0.308 (1, 164)	0.579
Chinese	32.18 (31.733,)32.623		
AAW			
Malay	35.48 (34.79, 36.17)	19.64 (1, 164)	0.001
Chinese	37.65 (37.03, 38.27)		
PAW			
Malay	47.93 (47.00-48.84)	2.00 (1, 164)	0.159
Chinese	48.85 (48.03-49.67)		
Lu			
Malay	17.82 (17.09-18.55)	1.026 (1, 164)	0.313
Chinese	18.34 (17.69-19.00)		

Table 3: ANCOVA for association between Maxillary Arch measurements and ethnicity controlling the effect of age and sex.

This table summarizes the results of four ANCOVA analyses. Each panel in the table corresponds to the ANCOVA table for each dental arch measurement.

Slu = sum of four upper incisors
AAW = anterior arch width measured from the cast
PAW = posterior arch width measured from the cast
Lu = arch length measured from the cast

Table 4: Comparison between actual values and index values of Maxillary Arch measurements (Dental Arch Measurements - DAM) in mm.

Dental Arch measurements (DAM)	Ethnic Malay				Ethnic Chinese			
	Mean	SD	Mean* Diff.	p-value Paired t	Mean	SD	Mean* Diff.	p-value Paired t
AAW	35.54	3.25	2.14	0.001	37.6	2.36	0.2	0.505
Pont's AAW*	37.68	2.69			37.8	2.05		
PAW	47.31	5.72	1.96	0.003	48.95	3.15	0.48	0.241
Pont's PAW**	49.27	3.52			49.43	2.69		
Lu	17.99	3.69	2.02	0.001	18.28	2.01	1.8	0.001
Korkhaus' Lu***	20.01	1.43			20.08	1.09		

Mean difference = Index value – actual value, **Slu**= sum of four upper incisors, **AAW** = anterior arch width measured from the cast (actual value), **AAW*** = anterior arch width based on Pont's index: Slu*100/85(Index value), **PAW** = posterior arch width measured from the cast (actual value), **PAW** ** = posterior arch width based on Pont's index: Slu*100/65(Index value), **Lu** = arch length measured from the cast(actual value), **Lu*** = arch length based on Korkhaus' index: Lu=Slu*100/160 (Index value).

Table 5: Comparison of differentials between actual Maxillary Arch measurements (Dental Arch Measurements - DAM) and the Indices across the ethnic groups.

Parameters of dental arch measurements	Ethnic Malays				Ethnic Chinese			
	Mean Differences (mm) (Index -Actual)			% within +/- 1 mm	Mean Differences (Index -Actual)			% within +/- 1 mm
	Min	Max	Mean		Min	Max	Mean	
AAW- Pont's	-17	8.41	2.14	20.7	-7.76	6.53	0.2	29.2
PAW – Pont's	-12	10.31	1.96	21.8	-8.17	13.11	0.48	36
Lu – Korkhaus'	-2.37	10.69	2.02	20.7	-3.75	6.19	1.8	25.8

Mean difference = Index value – actual value, **Slu**= sum of four upper incisors, **AAW** = anterior arch width measured from the cast (actual value), **AAW*** = anterior arch width based on Pont's index: Slu*100/85(Index value), **PAW** = posterior arch width measured from the cast (actual value), **PAW** ** = posterior arch width based on Pont's index: Slu*100/65(Index value), **Lu** = arch length measured from the cast(actual value), **Lu*** = arch length based on Korkhaus' index: Lu=Slu*100/160 (Index value).

The differentials (actual values of arch width versus values by Pont's indices) of Malays were significantly greater than those of Chinese at $p<0.05$ (independent t-tests), whereas the differentials (actual value of arch length versus Korkhaus' index) was not.

Table 6: Comparison of Head measurements in mm between ethnic groups.

Head measurements	Ethnic group	N	Mean	SD	Mean* Difference	p-value t-test
g_op	Malay	87	177.2	7.58	5.16	0.001
	Chinese	89	182.36	7.87		
zy_zy	Malay	87	135.16	6.48	3.44	0.004
	Chinese	89	131.72	8.96		
eu_eu	Malay	87	152.85	5.41	3.71	0.001
	Chinese	89	156.56	6.5		
CI (%)	Malay	87	86.39	4.34	0.44	0.486
	Chinese	89	85.95	4		

g_op = Maximum skull length
zy_zy = Bizygomatic diameter
eu_eu = Maximum skull breadth (Bieuryuonic diameter)
CI = Cephalic Index = **(eu_eu/g_op)* 100**

Table 7: Comparison of Head measurements in mm between gender.

Head measurements	Gender	N	Mean	SD	Mean* Difference	p-value t-test
g_op	Male	79	184.02	7.35	7.62	0.001
	Female	97	176.4	7.04		
zy_zy	Male	79	136.15	7.33	4.97	0.001
	Female	97	131.18	7.83		
eu_eu	Male	79	156.96	5.8	4.04	0.001
	Female	97	152.92	6.01		
CI (%)	Male	79	85.38	3.77	-1.43	0.024
	Female	97	86.81	4.36		

g_op = Maximum skull length
zy_zy = Bizygomatic diameter
eu_eu = Maximum skull breadth (Bieuryuonic diameter)
CI = Cephalic Index = **(eu_eu/g_op)* 100**

All measurements except CI are significantly different between males and females at $p< 0.05$ level (independent t-tests)

Table 8: ANCOVA for association between head measurements and ethnicity controlling the effect of age and sex.

Head measurements	Adjusted Mean (95% CI) in mm	F statistics (df)	P-value
g_op			
Malay	177.85 (176.15-179.55)	10.593 (1, 167)	0.001
Chinese	181.81 (180.26-183.36)		
zy_zy			
Malay	135.22 (133.51-136.92)	9.541 (1, 167)	0.002
Chinese	131.44 (129.88-132.99)		
eu_eu			
Malay	153.18 (151.77-154.58)	10.729 (1, 167)	0.001
Chinese	156.49 (155.20-157.77)		
CI			
Malay	86.25 (85.25-87.25)	0.014 (1, 167)	0.905
Chinese	86.16 (85.25-87.08)		

This table summarizes the results of four ANCOVA analyses. Each panel in the table corresponds to the ANCOVA table for each head measurement.

g_op = Maximum skull length
zy_zy = Bizygomatic diameter
eu_eu = Maximum skull breadth (Bieuryuonic diameter)
CI = Cephalic Index = **(eu_eu/ g_op)* 100**

Table 1 shows the distribution of the respondents by gender and ethnic groups. The sample consisted of 87 (49%) Malays and 89 (51%) Chinese. Males were over-represented among Chinese (57% vs. 32%) whilst there were more females among Malays. When combined, there were more males. Mean ages were 23.5 yr and 21.1 yr for Malays and Chinese respectively ($p < 0.05$). All DAM (Dental Arch Measurements of the Maxilla) were greater among males than females, however, only AAW and PAW showed significant differences. All measures indicated Chinese having larger dental arch sizes than Malays; however, only AAW and PAW were significantly different between two ethnic groups (Table 2). The ANCOVA results portrayed in the Table 3 show age-and-sex- adjusted means of DAM by ethnic groups; only the adjusted mean of AAW among Chinese was significantly larger than that among Malays.

The mean differences shown in Table 4 were subjected to the paired t test. This analysis reveals that the DAM as predicted by the Indices were significantly greater than those directly measured on the casts ($p <0.05$) among the Malays. Among the Chinese, however, only Korkhaus' Index was significantly larger than Lu by 1.8mm.

Table 5 portrays the distribution of the differentials between observed value and index value of DAM at the individual levels. About 20% of the index values were within the acceptable differential of 1 mm above or below the observed values (actual measurements on casts) among Malays, and 26% to 36% among the Chinese. Thus about 79 % of Pont's Index for AAW, Pont's Index for PAW and Korkhaus' Index for Lu were overestimating their corresponding AAW, PAW and Lu among the Malays. Among Chinese, the corresponding figures were 70%, 64% and 74% respectively. It indicates that DAM did not increase in size proportionately with increase in mesiodistal distances of the upper incisors in our study subjects. This discrepancy was higher among Malays than Chinese.

As shown in Tables 6, head measurements for Chinese were significantly larger than those of Malays in g_op (5 mm) and eu_eu (3.7mm). However, zy_zy of Malays was significantly larger (by 3 mm) than that of Chinese. CI, on the other hand, was similar. The unadjusted means of all head measurements except CI were significantly larger among males than females (Table 7); CI was larger among females by 1.4%. Analysis of covariance results in Table 8 also supports the univariate findings.

Correlation between bizygomatic diameter (head form) and anterior arch width (AAW) (arch form) among Malays were found to be weak and not significant. It was 0.01, 0.22, and 0.18 for males, female and total, respectively. Among Chinese, this correlation was significant though weak for total ($r = 0.3$, $P = 0.01$) and significant for male or female. Almost similar findings were observed for correlation between bizygomatic diameter and posterior arch width (PAW).

DISCUSSION

A study done on a group of ethnic Chinese population on Maxillary arch dimensions reported mean anterior arch width of 35.74 (SD= 2.17mm), and mean width of central incisors 8.85 mm (SD= 0.59mm)[9]. These findings are consistent with our results with Chinese's AAW of 37.6mm (SD=2.36mm), and Malay's AAW of 35.54mm (SD=3.25mm). The mean AAW of Chinese was significantly greater than that of Malays. Mean width of central incisors for Malay was 8.9 mm (SD= 0.59) and for Chinese 8.6 mm (SD = 0.44). In the morphological studies on the dental arch and palate of the Chinese in Fukien Province, Taiwan, the materials used consisted of plaster casts of the upper dentitions of 65 males and 69 females with normal occlusion, aged from 20 to 22 years. The dental arch of the male was larger than that of the female, the difference being significant for the anterior and posterior widths of the arch. The correlation coefficients were generally lower in the female than in the male [10]. These findings tally with our study. Correlation coefficient between AAW and PAW among our males subjects was 0.59 ($P<0.01$); females 0.57 ($P<0.01$). Ethnically, AAW-PAW correlation of Malays was much higher than that of Chinese ($r = 0.67$ vs. 0.51).

In another study significant differences between the arch width measurements were found to exist between several classes of subjects based

on race and sex [11]. The results of one research showed wider PAW for the Egyptians than for the Filipinos, who also showed wider AAW than the Saudi Arabians [12].

Knowledge of DAM (Dental Arch Measurement) is essential in pre-treatment decision making for treatment of malocclusion. One study found that the mesiodistal tooth widths of the patients with crowded dentition were significantly larger than those of the non-crowded group. The dental arch widths of the crowded group were significantly smaller than those of the non-crowded group [13].

There are not many studies which set up the norms of DAM. Many studies available for reference focus on the effect of some cranio-facial anomalies and surgical procedures on DAM [14, 15]. Some studies simply describe the racial and hereditary influences on these measurements [1, 16]. Since our study was designed to include subjects of pure Malay and Chinese ethnic groups, matured and with no dental abnormalities, the parameters thus obtained may represent ethnic Malays and Chinese who share the same geographical environment as our study subjects.

There was a controversy on the usefulness of Pont's Index as seen in a study aimed to evaluate Pont's Index in untreated, non-crowded samples of Australian Aborigines, Indonesians, and Whites. A considerable individual variability was noted in each population with regard to the difference between observed values and Pont's estimates, ranging from -5.9 mm to +6.2 mm (AAW) and -6.1 mm to +12.7 mm (PAW)[17] which were comparable with our results shown in Table 5. No person displayed the ideal arch dimensions predicted by the Index, but values were within +/- 1.0 mm for 17.5% of the Indonesian sample, 20.6% of the Aboriginal sample, 30.8% of the White sample [17]. In our study the corresponding values ranged form 21% to 22% for Malays and 26% to 36% for Chinese**.** Dental arch width was generally underestimated by the Index in Indonesians who tended to display relatively small tooth size and large arch width. This was the case for our study subjects with a greater magnitude among the Malays than the Chinese (Table 5).

A more even distribution of estimates was noted in Australian Aborigines and White subjects, with the Aborigines showing large tooth size and broad dental arches, and the White subjects displaying smaller tooth size and narrow arches. Correlation coefficients computed between observed and expected values were low in all three populations studied (range r = 0.01 to r = 0.56) [17]. Results of one study[18] showed a weak correlation between the SIu and the AAW (r = 0.27) and PAW (r = 0.21). The correlation between mandibular plane angle and AAW (r = 0.58) and PAW (r = 0.46) was fair. By taking into account the variations in the mandibular plane angle, the Pont's Index could be predicted with greater accuracy. The correlation between the SIu and the corrected AAW and PAW were very strong (r = 0.85 and 0.82, respectively). We did not attempt to incorporate measures of mandibular plane angle which involve radiological examination because of cost and ethical issues.

Correlation and regression analyses between actual DAM of the casts and Index values were performed. Because the data, especially for Malays were found to be skewed even after various transformation procedures, the results were valid and not presented. Even though the Chinese showed a relatively more favorable comparability between observed DAM and the Indices as seen in Table 5, the correlation coefficients were very small. Thus the Pont's and Korkhaus' indices consistently over-estimated the dental arch widths and lengths. The existence of negative correlation between arch width and arch length was not supported by the results of our study. Our study subjects' arch widths were not proportionately wide with increasing size of incisors and therefore arch length did not get shortened proportionately. In a similar study, maxillary arch dimensions conducted on Chinese adult subjects revealed poor correlation between tooth size variation and arch width variation. The author concluded that this variation could be attributed to differences in the genetic inheritance in different racial types [17].

With respect to the cephalic index, our study subjects were found to be brachycephalic with

no gender difference, was consistent with findings of Diament and Rodrigues [19]. The reference values for cephalic index have been stated in the introduction. The CI's of some nationals are Japanese 81%, Chinese 82%, Siberian 82%, Korean 83%, Indian (Veda) 76% and Indian (Brahmins) 79%. Generally, Chinese, Japanese, Koreans and Filipinos were characterized by longer lateral and smaller anteroposterior dimensions relative to Caucasians [20]. Knowledge about the trend of CI over time by doing a cohort analysis of CI data of a country by ages may be useful for testing the evidence of effect of environment on the anthropometric dimensions of a population. The results of one study show that the CI among Jordanians changed with economic condition that prevailed when the person was born [21]. The mean of cephalic index of Japanese girls was estimated as 87.0 indicating hyper brachycephalic[22] .Since the CI of the female farm workers in North Kyushu about 30 years ago were 81.0% and 81.1%, the remarkable increase of the cephalic index in the present study may represent an example of the rapid brachycephalization of the present people. Increases in head breadth have been the main cause of brachycephalization, and its pattern of secular change is very similar to that in height. Brachycephalization is thought to result from increases in the growth rate for head breadth caused by improvements in nutritional levels, as seen in increases in height. Increases in height over the last 100 years have been accompanied by brachycephalization in Japanese and Koreans, but by debrachy-cephalization in many European populations [23]. Increases in lateral growth in Asian heads may be related to the facial flatness which is characteristic to northern Mongoloid populations.

A weak correlation was found between the bizygomatic width and both anterior and posterior arch widths. This finding was not consistent with that reported by some researchers [24], where they found a strong correlation between the zygomatic arch width and posterior dental arch width of maxilla. Their analysis was based on the data obtained from the models and anthropological measurements of 50 adult German subjects with fairly eugnathic dentition, and their dental arch widths showed a perfect correlation with Pont's Indices.

It is concluded that Pont's index is unlikely to be a useful clinical predictor of dental arch width and should not be used as a guide to dental arch development in contemporary ethnic Malay and Chinese populations [18]. A norm estimated from our study population should be farther verified and compared with those of other ethnic groups in Malaysia as regard to the DAM (Dental Arch Measurements) and its relationship to the head form. It is instructive that ethnic Chinese has significantly greater arch widths than Malays. This information in conjunction with other dental and anthropometric parameters may be valuable in orthodontic and forensic sciences.

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Conflicts of Interests: None

REFERENCES

[1]. Cassidy, K.M., et al., Genetic influence on dental arch form in orthodontic patients. Angle.Orthod., 1998;68(5):445-454.

[2]. Pont A., Der zahnindex in der Orthodontie. Z. zahnartl. Orthop., 1909;3(306).

[3]. Linder, H., Biometrische Untersuchungen des Normalgebisses in verschiedenen Lebensaltern. Fortschr, Orthodont, 1931;1(22):211-214. (Cited by Rokosi et al, 1993)

[4]. Korkhaus, Handbuch der Zahnheilkunde Kiefer- und Gesichtsorthopadie. 1939: Bd. IV. Bergmann, Munchen. (Cited by Rokosi et al, 1993)

[5]. Rakosi, T., Jonas,I.,Graber,TM, Orthdontic Diagnosis. First ed. ed. 1993: Thieme Medical Publisher, New York.

[6]. Williams, P., Bannister, L.H., Berry, M.M., Collins, P. Dyson,M., Dussak, J.E., and Ferguson, M.W.J : Gray's anatomy. In :Skeletal system. 38th Edn; Churchill Livingston. London, pp :607-612. (1995).

[7]. Efron, B. and R. J. Tibshirani. An Introduction to the Bootstrap. 1993: New York: Chapman & Hall.

[8]. Stata, Stata Statistical Software: Release 7.0. 2001, Stata Corp: Houston, TX.
[9]. Keng S.B. and K.W. Foong. Maxillary arch and central incisor dimensions of an ethnic Chinese population in relation to complete denture prosthodontics. Int.Dent.J., 1996;46(2):103-107.
[10]. Chen, J., Morphological studies on the dental arch and palate of the Chinese Fukien Province, Taiwan, using Moire patterns. Aichi Gakuin Daigaku Shigakka Shi, 1990;28(4):1181-1197.
[11]. Barsley, R.E. and D.M. Lancaster, Measurement of arch widths in a human population: relation of anticipated bite marks. J Forensic Sci, 1987;32(4):975-982.
[12]. Diwan, R. and J.M. Elahi, A comparative study between three ethnic groups to derive some standards for maxillary arch dimensions. J Oral Rehabil, 1990;17(1):43-48.
[13]. Chang, H.F., Y.Y. Shiau, and K.C. Chen, The relationship of dental crowding to tooth size, dental arch width, and arch depth. Proc Natl Sci Counc Repub China B, 1986;10(4):229-235.
[14]. Noroozi, H. and R. Saeeda, Interrelationships between the width, depth, and perimeter of the dental arch. Int.J.Adult.Orthodon.Orthognath.Surg. 2000. Spring; 2000;15(1.):69.-71.
[15]. Ong, H.B. and M.G. Woods, An occlusal and cephalometric analysis of maxillary first and second premolar extraction effects. Angle.Orthod. 2001.Apr.;71(2):90-102.
[16]. Liu, K.L., Dental condition of two tribes of Taiwan aborigines—Ami and Atayal. J.Dent.Res., 1977;56(2):117-127.
[17]. Dalidjan, M., W. Sampson, and G. Townsend, Prediction of dental arch development: an assessment of Pont's Index in three human populations. Am.J.Orthod.Dentofacial.Orthop., 1995;107(5):465-475.
[18]. Lew, K., The effect of variations in the mandibular plane angle on the Pont's Index. Funct Orthod, 1991;8(2): 24-27.
[19]. Diament, A.J. and F.W. Rodrigues, Cephalic measures in normal pre-school children 3 to 7-years of age. Arq.Neuropsiquiatr., 1976;34(4):325-330.
[20]. Chung, C.S., et al., Effects of interracial crosses on cephalometric measurements. Am.J.Phys.Anthropol., 1986;69(4):465-472.
[21]. Dalou, A.A., Head shape of adult males as a possible indicator of economic changes in northern Jordan (1900-1978). USA. 2000, Dept.of Anthropology, University of Missouri: Columbia, MO, 65211, USA.
[22]. Nakashima, T., Brachycephalization in the head form of school girls in North Kyushu. J Uoeh, 1986;8(4):411-414.
[23]. Kouchi, M., Brachycephalization in Japan has ceased. Am J Phys Anthropol, 2000; 112(3):339-347.
[24]. Sergl, H.G., et al., [A dental arch index related to tooth size and facial breadth] Ein zahngrossen- und gesichtsbreitenbezogener Zahnbogenindex. Fortschr.Kieferorthop., 1994;55(3):119-125. (Cited by Rokosi et al, 1993)

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