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Mixed dentition analysis for black Americans

Harvey H. Frankel, DMD Edward M. Benz, DMD

Abstract

The mixed dentition analysis described by Moyers, and later validated by Tanaka, was performed on 80 American blacks to compare prediction equations between Caucasians and blacks. For the black sample, separate regression formulas were determined for the 39 males and 41 females and the combined black sample. Although sexual dimorphism of tooth size was not a consideration in the Moyers prediction charts, this research evaluated the effect of sexual dimorphism in the mixed dentition analysis.

Regression equations were generated by the method of least squares, and the 2-tailed t-test was used to determine significant differences between 2 equations for the same arch.

The findings include a significant difference for the mandibular regression equation for black males when compared with (1) the Tanaka equation for Caucasians, and (2) the regression equation for black females. Maxillary regression equations were not significantly different between the Caucasian and black samples or between black males and females.

Frequently in pediatric dental practice the dentist must manage and guide the mixed dentition of a child into the permanent occlusion, with space available and tooth size intimately being involved in treatment planning. A reliable method of determining tooth size while the tooth is still within the dental follicle and surrounded by bone will aid treatment planning.

There have been reports in the literature on methods for predicting the mesiodistal dimension of unerupted canines and premolars in Caucasians.[1-11] Sexual dimorphism has been investigated with respect to tooth size prediction,[12,13] and radiographic[4,5,7,14-18] as well as combination[19,20] techniques are available for Caucasians.

There are, however, few reported studies concerning the mesiodistal dimension of the buccal teeth in the American black[21-23] and only 1 study to evaluate the widely used mixed dentition analysis of Moyers for the black child.[24] Sexual dimorphism was not considered for this investigation.[25] Recent comparisons among the alternative methods for prediction of tooth size in Caucasians has been researched.[26-28] In the present study, a statistical analysis for blacks was performed and the sample also was segregated into male and female groups to determine the effect of sexual dimorphism of tooth size on the mixed dentition analysis.

Methods and Materials

The materials for this study consisted of stone casts of the dentition of 80 black children (39 males, 41 females) who presented with complete eruption of permanent mandibular incisors, canines, and premolars, as well as maxillary canines and premolars. These children were selected from the population of patients seen at the Children's Hospital of Pittsburgh Dental Clinic. Criteria for selection were based on complete fulfillment of the following.

1. The patient had to be of probable American black heritage for at least 2 prior generations.
2. None of the teeth to be measured could show proximal caries, restorations, or fractures as determined by bite-wing radiographs.
3. The patient had to be free of systemic disease; however, 1 female was diagnosed with juvenile diabetes mellitus at age 12.
4. There was to be no clinical evidence of hypoplasia or hypocalcification to the teeth being measured.
5. A maximum of 19 years of age was used in order to preclude any discrepancies based on secular trends or significant proximal wear.

All individuals selected for this study were between 12 and 17 years without prior orthodontic treatment. Impressions were made with a fast-set irreversible hydrocolloid material[a] and poured with white dental stone within 1 hr.

The mesiodistal width of a tooth was obtained by

[a] Jeltrate®—L. D. Caulk Co., Milford, DE.

Table 1. Mean, Range, and Standard Deviation of Tooth Sizes from Black Population Sample from this Study in Millimeters

	Males		*Females*		
Tooth	*Mean 1 SD*	*Range*	*Mean 1 SD*	*Range*	*t-value*
$\bar{1}$	5.47 ± 0.40	4.7-6.7	5.47 ± 0.39	4.4-6.5	
$\bar{2}$	6.06 ± 0.46	5.1-7.3	6.00 ± 0.37	5.1-6.9	
$\overline{21/12}$	23.06 ± 1.59	20.6-27.2	22.94 ± 1.28	19.9-25.5	0.38
$\bar{3}$	7.23 ± 0.53	6.4-8.7	6.80 ± 0.46	6.0-7.8	
$\bar{4}$	7.60 ± 0.53	6.2-8.8	7.38 ± 0.42	6.4-8.5	
$\bar{5}$	7.68 ± 0.61	6.3-8.8	*7.40 ± 0.41	6.1-8.4	
$\overline{345}$	22.57 ± 1.45	19.2-25.6	21.58 ± 0.94	19.2-23.8	3.64*
$\underline{3}$	8.06 ± 0.48	7.2-9.3	7.55 ± 0.37	6.5-8.4	
$\underline{4}$	7.36 ± 0.55	6.2-8.8	7.29 ± 0.36	6.5-8.5	
$\underline{5}$	7.03 ± 0.53	5.7-8.2	6.91 ± 0.40	5.8-7.8	
$\underline{345}$	22.53 ± 1.30	19.7-25.6	21.78 ± 0.83	19.7-23.8	3.08*

t-test significance: * $P < 0.01$.

measuring the greatest distance between contact points on the proximal surfaces. A Boley gauge with a vernier scale to read to the nearest 0.1 mm was held parallel to the occlusal surface if the tooth appeared to be in normal alignment. Otherwise, the mesiodistal crown diameter was obtained by measuring between the points where contact with the adjacent tooth would normally occur. The teeth measured were the mandibular permanent central and lateral incisors (4), the maxillary and mandibular permanent canines (4), and the maxillary and mandibular premolars (8).

All teeth involved in the study were measured independently by 2 pediatric dentists, utilizing like calipers following standardization as previously discussed.

The range, mean, and standard deviation computed by the method of least squares were determined for each tooth, i.e., $\bar{1}$, $\bar{2}$, $\bar{3}$, $\bar{4}$, $\bar{5}$, $\underline{3}$, $\underline{4}$, $\underline{5}$.

Subsequent to the accumulation of the data for the individual teeth, appropriate tooth group measurements were determined by summing the mesiodistal dimensions of the teeth within the group. The groups consisted of the mandibular permanent incisors ($\overline{21/12}$), right and left permanent mandibular and maxillary canine and premolars (345). The average between the measurements of the 2 investigators was utilized for each of the 5 groups. Values obtained for the right and left posterior segments then were averaged, so that there would be 1 value for $\underline{345}$ and $\overline{345}$ for each value of $\overline{21/12}$. The range, mean, and standard deviation were computed for the tooth groups, and the 2-tailed *t*-test was applied to determine significant difference between males and females for the tooth groups.

Following the statistical method of least squares, linear regression equations of the form: $345 = (m)\ \overline{21/12} + b$, were developed.

Applying these statistical calculations to the raw data for the black males, the black females, and the combined black sample, for the maxillary and the mandibular arches, 6 linear regression equations were obtained. The degree of correlation between the size of the mandibular incisors and the canine/premolar measurement then was determined by the coefficient of linear correlation (r). Then, applying the 2-tailed *t*-test, significant differences between 2 regression equations were determined.

Each of the 6 regression equations was compared with the regression equation reported by Tanaka for the appropriate arch. In addition, the regression equations for black males and black females were compared for the appropriate arch.

Results

The results of this investigation are presented in 3 parts: the individual teeth and tooth group statistics; the regression equations and correlation coefficients for the regression analysis; and the comparison between these equations and those reported by Tanaka.

Part 1—Individual Teeth and Tooth Group Statistics

Table 1 contains the descriptive statistics for the mesiodistal diameters of the mandibular incisors and the canines and premolars of both arches. The values for the males and females were computed separately and thus permit comparison with previously report-

Table 2. Maxillary Regression Equations

Sample	*Regression Equation*	*Correlation Coefficient*	*Standard Error of Estimate*
Black females	$\underline{345} = (0.39)\ \overline{21/12} + 12.83$	$r = +0.61$	0.672
Black males	$\underline{345} = (0.58)\ \overline{21/12} + 9.15$	$r = +0.72$	0.923
Combined blacks	$\underline{345} = (0.52)\ \overline{21/12} + 10.18$	$r = +0.65$	0.870
Combined Caucasians (Tanaka)	$\underline{345} = (0.506)\ \overline{21/12} + 10.405$	$r = +0.6247$	0.855

Table 3. Mandibular Regression Equations

Sample	*Regression Equation*	*Correlation Coefficient*	*Standard Error of Estimate*
Black females	$\overline{345} = (0.49)\ \overline{21/12} + 10.34$	$r = +0.66$	0.709
Black males	$\overline{345} = (0.72)\ \overline{21/12} + 5.97$	$r = +0.79$	0.911
Combined blacks	$\overline{345} = (0.64)\ \overline{21/12} + 8.30$	$r = +0.70$	0.948
Combined Caucasians (Tanaka)	$\overline{345} = (0.537)\ \overline{21/12} + 9.178$	$r = +0.6483$	0.852

ed tooth sizes by Moorrees et al.[29] for Caucasians and Richardson and Malhotra[22] for blacks. Since the values for the means of the tooth groups is very close (0.00–0.08 mm) to the sum of the means of the individual teeth within the group, the authors extrapolated the Moorrees and the Richardson data to determine the means of the tooth groups from their studies. The mesiodistal tooth sizes of the teeth and tooth groups from this study are in closer agreement with the Richardson black sample than the Moorrees Caucasian sample.

Part 2—Regression Equations and Correlation Coefficients

Following the guidelines for statistical analysis as described in the methodology, linear regression equations and correlation coefficients were determined for the black males and black females separately, as well as for the combined black population. These results are presented in Tables 2 and 3 for the maxillary arch and the mandibular arch, respectively. The Tanaka statistics are included for comparison.

Part 3—Comparison Between Regression Equations

Employing the 2-tailed *t*-test to the regression equations obtained in this study and Tanaka's investigation, it is possible to determine where a significant difference exists between any 2 linear regressions. Table 4 demonstrates that only 2 pairs of regressions are significantly different up to the 90% level of confidence. They are both for the *mandibular* arch. The first, which is significant at the 95% level of confidence, is between the black males and the Tanaka regression. The second, at the 90% level, is between the black males and black females.

Discussion

Regression equations used for predicting the size of unerupted teeth are based on genetic inheritance of tooth size. The reliability of applying this information to pediatric dental treatment planning depends largely on probability. Apparently, a more accurate mixed dentition analysis can be obtained by segregating racial groups and the sexes when determining the prediction regression equations. This is based on previously published reports of tooth size differences for Caucasians and blacks, as well as sexual dimorphism of tooth size. The findings of the present study support this view, and charts for predicting the mesiodistal width of the canine/premolar segment for black males and black females are presented in Tables 5 and 6, respectively. The charts are designed similar to the Moyers prediction chart for Caucasians, containing percentile confidence intervals. For example, when using the 95%, one can expect that the mesiodistal width of the canine/premolar segment will not be greater than the given width in 95% of the cases tried.

Using the mixed dentition analysis for pediatric dental treatment planning can be a valuable asset, especially in early mixed dentition cases with slight to moderate anterior crowding. Will the leeway space be sufficient to accommodate the permanent dentition? How much leeway space can be anticipated? Are permanent tooth extractions inevitable or avoidable? These considerations may be understood better with the aid of a more accurate mixed dentition analysis. The research to date, as well as this study, support the view that racial differences and sexual dimorphism are likely to be important variables in tooth size prediction equations.

Conclusions

1. A mixed dentition analysis, after the methods of Moyers and Tanaka, was applied to 80 American blacks, 41 females and 39 males.

Table 4. Results of 2-Tailed *t*-Test Comparisons on Linear Regression Pairs

Regression Pair	*t-value*	
	Maxilla	*Mandible*
Tanaka vs. comb. black	0.1903	1.3697
Tanaka vs. black male	0.6661	1.9848*
Tanaka vs. black female	1.0644	0.4364
Black male vs. black female	1.359	1.760**

t-test significance: * $P < 0.05$; ** $P < 0.10$.

Table 5. Probability Chart for Predicting the Sum of the Widths of 345/345 from 21/12

	American Black Males 21/12											
	20.0	*20.5*	*21.0*	*21.5*	*22.0*	*22.5*	*23.0*	*23.5*	*24.0*	*24.5*	*25.0*	*25.5*
95%	22.3	22.6	22.8	23.1	23.4	23.7	24.0	24.3	24.6	24.9	25.2	25.4
	21.9	22.2	22.6	23.0	23.3	23.7	24.0	24.4	24.7	25.1	25.5	25.8
85%	21.7	22.0	22.3	22.6	22.9	23.2	23.4	23.7	24.0	24.3	24.6	24.9
	21.3	21.7	22.0	22.4	22.8	23.1	23.5	23.8	24.2	24.6	24.9	25.3
75%	21.4	21.7	22.0	22.2	22.5	22.8	23.1	23.4	23.7	24.0	24.3	24.6
	21.0	21.3	21.7	22.1	22.4	22.8	23.1	23.5	23.9	24.2	24.6	24.9
65%	21.1	21.4	21.7	22.0	22.3	22.6	22.8	23.1	23.4	23.7	24.0	24.3
	20.7	21.1	21.4	21.8	22.2	22.4	22.8	23.1	23.5	23.9	24.2	24.6
50%	20.8	21.0	21.3	21.6	21.9	22.2	22.5	22.8	23.1	23.4	23.6	23.9
	20.4	20.7	21.1	21.4	21.8	22.2	22.5	22.9	23.2	23.6	24.0	24.3
35%	20.4	20.7	21.0	21.3	21.6	21.8	22.1	22.4	22.8	23.1	23.4	23.7
	20.0	20.4	20.7	21.1	21.5	21.8	22.2	22.5	22.9	23.3	23.6	24.0
25%	20.1	20.4	20.7	21.0	21.3	21.6	21.9	22.2	22.4	22.7	23.0	23.3
	19.8	20.1	20.5	20.8	21.2	21.6	21.9	22.3	22.6	23.0	23.4	23.7
15%	19.8	20.1	20.4	20.7	21.0	21.2	21.5	21.8	22.1	22.4	22.7	23.0
	19.4	19.8	20.2	20.5	20.9	21.2	21.6	22.0	22.3	22.7	23.0	23.4
5%	19.2	19.5	19.8	20.1	20.4	20.7	21.0	21.3	21.6	21.8	22.1	22.4
	18.9	19.2	19.6	20.0	20.3	20.7	21.0	21.4	21.8	22.1	22.5	22.8

2. Regression equations for the combined black males and females were found to be in close agreement with Tanaka's regression equations for the *maxillary* and *mandibular* arches.
3. Significantly different regression equations were found between black males and females for the *mandibular* arch.
4. Significant differences were found for black males in comparison to the Caucasian sample of Tanaka for the *mandibular* arch.

Table 6. Probability Chart for Predicting the Sum of the Widths of 345/345 from 21/12

	American Black Females 21/12											
	20.0	*20.5*	*21.0*	*21.5*	*22.0*	*22.5*	*23.0*	*23.5*	*24.0*	*24.5*	*25.0*	*25.5*
95%	21.7	21.9	22.1	22.3	22.5	22.7	22.9	23.1	23.3	23.5	23.7	23.9
	21.3	21.6	21.8	22.0	22.3	22.5	22.8	23.0	23.3	23.5	23.8	24.0
85%	21.3	21.5	21.7	21.9	22.1	22.3	22.5	22.7	22.9	23.1	23.3	23.5
	20.9	21.1	21.4	21.6	21.8	22.1	22.3	22.6	22.8	23.1	23.3	23.6
75%	21.1	21.3	21.5	21.7	21.9	22.0	22.2	22.4	22.6	22.8	23.0	23.2
	20.6	20.9	21.1	21.4	21.6	21.8	22.1	22.4	22.6	22.8	23.1	23.3
65%	20.9	21.1	21.3	21.5	21.7	21.9	22.1	22.3	22.4	22.6	22.8	23.0
	20.4	20.6	20.9	21.2	21.4	21.6	21.9	22.1	22.4	22.6	22.9	23.1
50%	20.6	20.8	21.0	21.2	21.4	21.6	21.8	22.0	22.2	22.4	22.6	22.8
	20.1	20.4	20.6	20.9	21.1	21.4	21.6	21.9	22.1	22.3	22.6	22.8
35%	20.4	20.6	20.8	21.0	21.2	21.3	21.5	21.7	21.9	22.1	22.3	22.5
	19.9	20.1	20.4	20.6	20.8	21.1	21.3	21.6	21.8	22.1	22.3	22.6
25%	20.2	20.4	20.6	20.8	21.0	21.2	21.3	21.5	21.7	21.9	22.1	22.3
	19.7	19.9	20.2	20.4	20.6	20.9	21.1	21.4	21.6	21.9	22.1	22.4
15%	19.9	20.1	20.3	20.5	20.7	20.9	21.1	21.3	21.5	21.7	21.9	22.1
	19.4	19.6	19.9	20.2	20.4	20.6	20.9	21.1	21.4	21.6	21.9	22.1
5%	19.5	19.7	19.9	20.1	20.3	20.5	20.7	20.9	21.1	21.3	21.5	21.7
	19.0	19.2	19.5	19.7	20.0	20.2	20.4	20.7	20.9	21.2	21.4	21.7

5. Separate percentile charts are provided for predicting tooth size for black males and black females.

Dr. Frankel is a clinical assistant professor at Children's Hospital of Pittsburgh and Dr. Benz is in private pediatric dental practice in Coraopolis, Pennsylvania. Reprint requests should be sent to: Dr. Harvey H. Frankel, Children's Hospital of Pittsburgh, 125 DeSoto St., Pittsburgh, PA 15213.

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