Original Article

The Dentition and Occlusal Development in Children of African American Descent

Biometrics of the Primary Dentition

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ABSTRACT

Objective: The objectives of this study were to (1) determine normative dental arch dimensions (arch length [AL], arch width [AW], arch perimeter [AP], and amount of interdental space [IDS]) in the primary dentition of African American (AA) children; (2) compare the established normative arch dimensions in AA children with their European American (EA) cohorts; and (3) contrast a theoretical construct of mandibular transitional occlusal development between children of AA and EA descent on the basis of normative values.

Materials and Methods: Two hundred seventeen sets of AA primary dental casts (110 boys, 107 girls) made from alginate impressions were measured and compared with historical EA standard values. Independent group *t*-tests were used to analyze sample differences.

Results: AA children showed significant ($P = .001$) sex differences in each respective dental arch dimension with the exception of the mandibular canine AW. AA boys and girls revealed statistically larger ($P = .001$) arch dimensions (AP, AL, AW) and amounts of IDS compared with their EA cohorts.

Conclusions: The total amount of IDS within the primary dental arches is approximately equal in AA boys and girls, but significant site-specific gender dimorphism existed. The primary dental arch dimensions of AA children were significantly larger than those of EA children in AW, AL, AP, and IDS.

KEY WORDS: African American; Primary dentition; Arch length; Arch perimeter; Arch width; Interdental space

INTRODUCTION

The biometrics of the primary dental arches serves as an important baseline for studying the biological phenomenon of growth and development of the human dentition and occlusion. Statistical evaluation of the primary dentition has been limited largely to subjects of northwest European[1–3] and European American (EA) descent.[4–6] Little is known regarding the biometric dimensions of the primary dentition of children of African American (AA) descent. Clinical investigations and epidemiological studies suggest population differences in tooth size,[7,8] dental arch crowding,[9] and distribution of occlusal relationships.[10–13] A baseline biometric comparison of the primary dental arch dimensions of the two populations is reported here.

The aim of the study was to (1) determine normative dental arch dimensions (arch length [AL], arch width [AW], arch perimeter [AP], and amount of interdental space [IDS]) in the primary dentition of AA children; (2) compare the established normative arch dimensions in AA children with their EA cohorts; and (3) contrast a theoretical construct of mandibular transitional occlusal development between children of AA and EA descent on the basis of central tendency values.

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MATERIALS AND METHODS

Human Sample Size, Source, and Selection

A convenience sample of 217 children of AA descent (110 boys, 107 girls) participated in the study. The demographics of the sample have been previously described.[13]

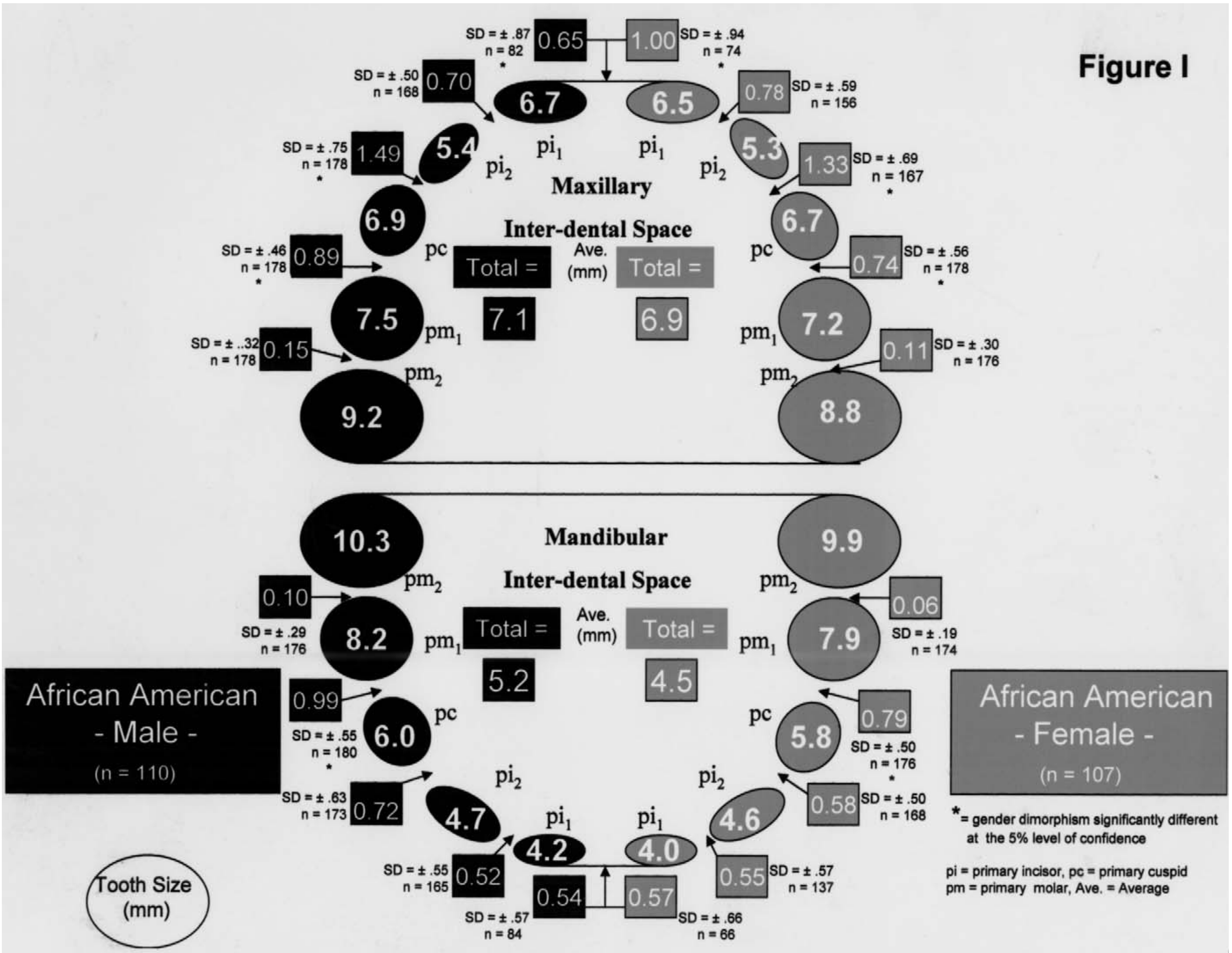

Figure 1. Statistical (mean, standard deviation) comparisons of interdental space in the primary dentition of African American children (both boys and girls).

Plaster Dental Cast, Reference Points, Measuring Technique, and Instrument Error

The biometric data for AW, AL, AP, and IDS of the AA sample were obtained from plaster dental casts made from alginate impressions. Reference points used to record AW, AL, AP, overbite (OB), and overjet (OJ) were the same as those described by Moyers et al.[5] The reference points for IDS were the same as those described by Moorrees.[4] There was a difference in the types of instruments used to determine IDS. Moorrees[4] used round wires of a predetermined gauge. A digital caliper (Sentry Dental, Farmingdale, NY) modified to access the IDS area was used in this study. There was also a difference in the types of instruments used to measure the arch dimensions (AP, AW, AL, OB, OJ). Moyers et al[5] used an Optocom microscope, whereas a digital caliper was used in this study. The AP for each respective dental arch was determined by adding the sum of the mesiodistal crown diameters of the 10 primary teeth plus the sum of the amount of IDS (Figure 1).

Each tooth and IDS was measured to two decimal places, and only the final sum total values for the respective teeth and IDS were rounded to one decimal place (Figure 1; Table 1, sample A). Double determination measurements by the same operator of AW at the maxillary canine were used to estimate error of method for this study. Moyers et al[5] conducted a similar study. The error of method determinations in AW were comparable for both instrument types (Optocom: n = 124, standard deviation [SD] = 0.20 mm; digital calipers: n = 150, SD = 0.23 mm). Similar SD values for OJ (0.21 mm for Optocom vs 0.24 mm for digital caliper) and OB (0.34 mm for Optocom vs 0.25 mm for digital caliper) were obtained. Failure to estimate the total measurement error for the respective studies may be cited as limitations of the data.

Dental Cast Selection Criteria

Dental cast selection criteria excluded primary dentitions with (1) anterior or posterior crossbites; (2) extracted or congenitally missing teeth; (3) caries and restorations involving the occlusal and proximal surfaces of the posterior teeth; (4) clinically discernible occlusal signs of digital and deglutition habits, which was assessed by clinical history and intraoral occlusal examination; and (5) patient history of orthodontic treatment. Measurements on some dental casts could not be obtained because of local model defects or teeth approaching exfoliation.

EA Samples

The historically reported EA standard values for AW, AL, AP, OJ, and OB of Moyers et al[5] (the larger sample size dictated the use of these data) (Tables 1–4) and the IDS standard values of Moorrees[4] were used for comparisons (Figures 2 and 3). The demographics of the contrasting EA human and dental cast samples have been previously described.[4,5]

Theoretical Construct of AW Increases

In this sample, the AW in the mandibular canine area was subsequently measured at two additional stages of dental development: (1) after the eruption of the permanent centrals (boys: n = 25, mean = 0.79 mm, standard error of the mean [SEM] = 0.32; girls: n = 27, mean = 0.80 mm, SEM = 0.32) and (2) after the eruption of the permanent lateral incisors (boys: n = 150, mean = 1.55 mm, SEM = 0.18; girls: n = 137, mean = 1.46 mm, SEM = 0.18). These data constituted the source of the growth estimates used to construct the theoretical transitional mandibular development exercise (AA, Figure 4). The EA sample theoretical construct (Figure 5) was based on the historical IDS values of Moorrees,[4] and AW changes, primary and permanent tooth sizes, sequence of tooth exchange, and IDS utilization was based on the historical data of Moyers et al.[14]

Statistical Computations

Descriptive statistics (arithmetic mean, SD, and observation counts [n]) were recorded for each dental arch parameter by sex. Sex differences and population comparisons were analyzed by using a two-sample independent group *t*-test at the 5% level of confidence. A *t*-test for equality of variances was performed for each recorded and contrasted mean, SD, and sample size (n). All statistical data computations were performed by using the Winks Software (Texa-soft Inc, Cedar Hill, Tex).

Table 1. Statistical (mean, standard deviation [SD]) comparisons of primary dental arch perimeter (AP): Sample A = African American (AA) boys vs AA girls, sample B = AA boys vs European American (EA) boys, and sample C = AA girls vs EA girls

Sample A	n	AP, mm	SD	*P* value
		Maxillary		
AA boys	91	79.2	±3.85	.015
AA girls	91	77.8	±3.85	
		Mandibular		
AA boys	91	72.2	±3.30	.001
AA girls	91	69.6	±3.30	
Sample B				
		Maxillary		
AA boys	91	79.2	±3.85	.007
EA boys	51	77.4	±3.49	
		Mandibular		
AA boys	91	72.2	±3.30	.001
EA boys	46	69.2	±2.82	
Sample C				
		Maxillary		
AA girls	91	77.8	±3.85	.021
EA girls	47	76.2	±3.71	
		Mandibular		
AA girls	91	69.6	±3.30	.007
EA girls	47	68.0	±3.23	

RESULTS

The results of measurements on 217 sets of dental casts (110 boys, 107 girls) of AA children are shown in Figure 1 and Tables 1 through 4, sample A. The results obtained on AA children were then compared with the historical data on EA children and depicted in Figures 2 and 3 and Tables 1 through 4, samples B and C. The samples contrasting theoretical constructs of segmental AP transitional development are illustrated in Figures 4 and 5.

Biometrics of the Primary Dentition of Children of AA Descent

Interdental space. In children of AA descent, the total amount of IDS in the respective dental arches of boys and girls was approximately equal (Figure 1), but sex differences were observed in the pattern of IDS distribution within the dental arches. Girls showed significantly larger amounts of IDS between the primary maxillary central incisors ($P = .017$). Boys showed significantly larger amounts of IDS mesial ($P = .041$) and distal ($P = .006$) to the maxillary canines and distal of the mandibular canines ($P = .001$). A majority of both sexes (99.1% boys and 96.3% girls) demonstrated the presence of a "primate space" localized mesial to the canine in the maxilla and distal to the canine in the mandible. Boys showed significantly larger primate

Table 2. Statistical (mean, standard deviation [SD]) comparisons of primary dental arch width (AW); sample A = African American (AA) boys vs AA girls, sample B = AA boys vs European American (EA) boys, and sample C = AA girls vs EA girls[a]

Sample A	n	Teeth	AW, mm	SD	P value
		Maxillary			
AA boys	97	pc to pc	31.3	±2.03	.007
AA girls	94	pc to pc	30.5	±2.03	
AA boys	93	pm_2 to pm_2	40.7	±1.98	.001
AA girls	91	pm_2 to pm_2	39.4	±2.20	
		Mandibular			
AA boys	90	pc to pc	24.4	±2.06	.342
AA girls	78	pc to pc	24.1	±2.01	
AA boys	95	pm_2 to pm_2	35.9	±2.00	.001
AA girls	92	pm_2 to pm_2	34.8	±2.12	
Sample B					
		Maxillary			
AA boys	97	pc to pc	31.3	±2.03	.001
EA boys	56	pc to pc	27.2	±1.36	
AA boys	93	pm_2 to pm_2	40.7	±1.98	.001
EA boys	55	pm_2 to pm_2	36.8	±1.69	
		Mandibular			
AA boys	90	pc to pc	24.4	±2.06	.001
EA boys	53	pc to pc	21.8	±1.28	
AA boys	95	pm_2 to pm_2	35.9	±2.00	.001
EA boys	56	pm_2 to pm_2	34	±1.72	
Sample C					
		Maxillary			
AA girls	94	pc to pc	30.5	±2.03	.001
EA girls	56	pc to pc	26.5	±1.55	
AA girls	91	pm_2 to pm_2	39.4	±2.20	.001
EA girls	55	pm_2 to pm_2	36.1	±2.10	
		Mandibular			
AA girls	78	pc to pc	24.1	±2.01	.001
EA girls	55	pc to pc	21.7	±1.26	
AA girls	92	pm_2 to pm_2	34.8	±2.12	.020
EA girls	55	pm_2 to pm_2	34	±1.77	

[a] pc indicates primary cuspid; pm, primary molar.

Table 3. Statistical (mean, standard deviation [SD]) comparisons of primary dental arch length (AL); sample A = African American (AA) boys vs AA girls, sample B = AA boys vs European American (EA) boys, and sample C = AA girls vs EA girls

Sample A	n	AL, mm	SD	P value
		Maxillary		
AA boys	80	31.0	±1.74	.006
AA girls	77	30.1	±2.26	
		Mandibular		
AA boys	85	27.5	±1.59	.012
AA girls	71	26.8	±1.83	
Sample B				
		Maxillary		
AA boys	80	31.0	±1.74	.001
EA boys	52	29.2	±1.66	
		Mandibular		
AA boys	85	27.5	±1.59	.001
EA boys	53	26.4	±1.06	
Sample C				
		Maxillary		
AA girls	77	30.1	±2.26	.001
EA girls	49	28.8	±1.87	
		Mandibular		
AA girls	71	26.8	±1.83	.001
EA girls	49	25.6	±1.44	

Table 4. Statistical (mean, standard deviation [SD]) comparisons of overjet (OJ) and overbite (OB) in the primary dentition; sample A = African American (AA) boys vs AA girls, sample B = AA boys vs European American (EA) boys, and sample C = AA girls vs EA girls

Sample A	n	OJ, mm	SD	P value	n	OB, mm	SD	P value
AA boys	70	2.1	± .81	1.00	64	1.7	± .76	.524
AA girls	54	2.1	± .77		54	1.6	± .94	
Sample B								
AA boys	70	2.1	± .81	.011	64	1.7	± .76	.009
EA boys	52	2.7	±1.51		46	1.0	±1.68	
Sample C								
AA girls	54	2.1	± .77	.019	54	1.6	± .94	.011
EA girls	47	3.2	±2.04		46	0.9	±1.59	

spaces than did girls in both dental arches (maxilla $P = .041$; mandible $P = .001$).

The absence of IDS was observed in 3.7% of the girls and 0.9% of the boys. The absence of spacing was confined almost exclusively to the mandibular dental arch in both sexes. Crowding of the primary dental arch (mandible) was observed in only two of the 217 AA primary dentitions (0.9%).

AP, AW, and AL. Boys showed larger biometric values for each of the respective arch dimensions (AP, AW, AL) compared with girls (Tables 1 through 3, sample A). Gender dimorphism was statistically significant ($P = .001$) for each arch dimension except for the mandibular canine-to-canine AW (Table 2, sample A).

OJ and OB. No significant sex difference was observed in the OJ or OB measurements (Table 4, sample A).

Tooth size. The tooth size[8] was included in Figures 1 and 4 to enable visualization of the technique of AP determination and to follow the stepwise construction of the theoretical exercises in Figures 4 and 5.

Biometric Comparisons Between AA and EA Children

Interdental space. Children of AA descent (both boys and girls) showed a mean of 49% more mandibular and 44% more maxillary IDS than did their EA cohorts (Figures 2 and 3).

AP, AW, and AL. The AP, AW, and AL measurements were significantly larger (range: $P = .021$ to P

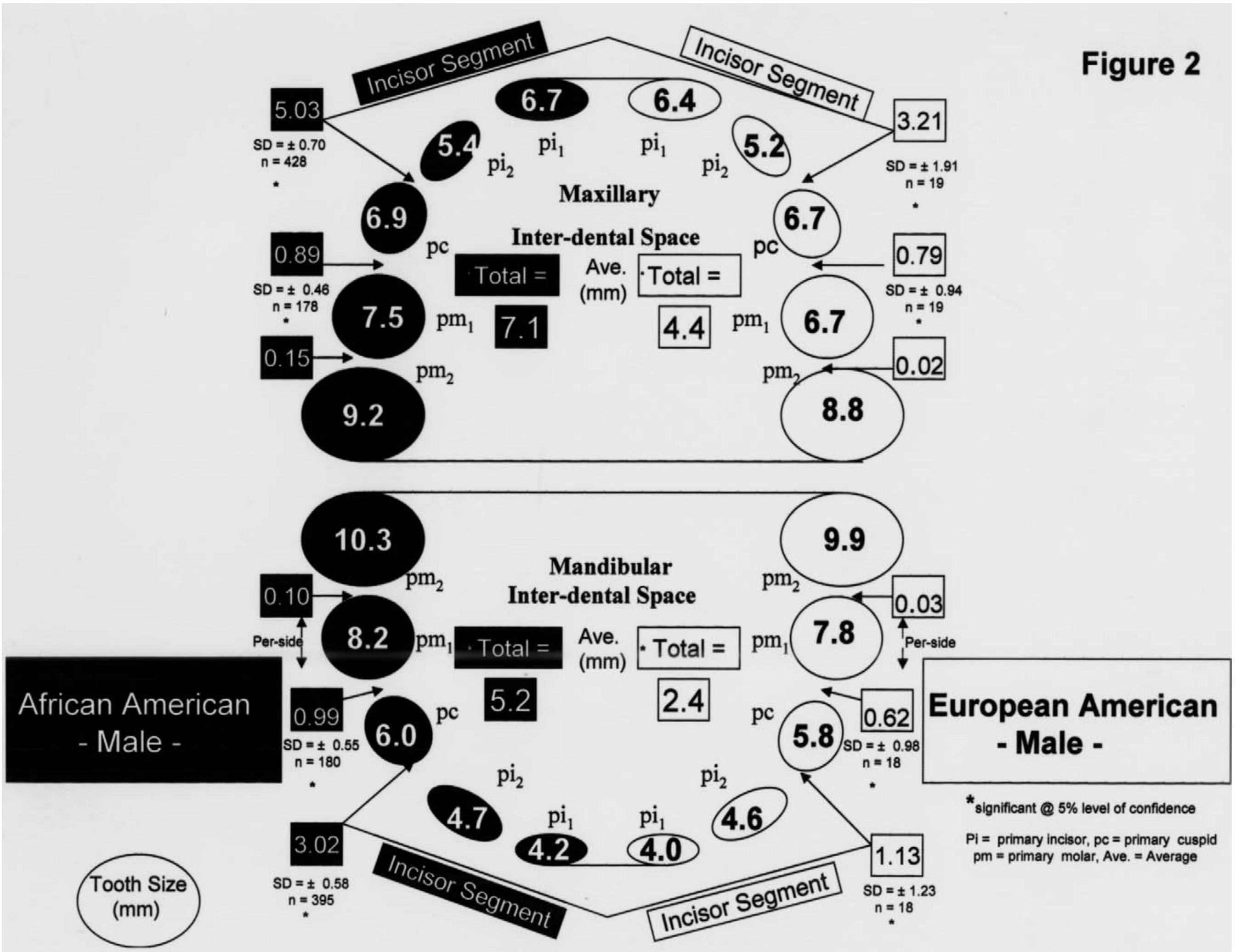

Figure 2. Statistical (mean, standard deviation) comparisons of interdental space in the primary dentition of African American and European American boys.

= .001) in AA children compared with EA children (Tables 1 through 3, samples B and C).

OJ and OB. AA children (both boys and girls) showed significantly less OJ and more OB compared with EA children (range: $P = .012$ to $P = .001$) (Table 4, samples B and C).

DISCUSSION

Current Findings Contrasted with Historical Data

Comprehensive biometric studies involving arch dimensions of the primary dentition and the trailing transitional dental arch development of EA children have been published by Moorrees[4] and Moyers et al.[5] The findings of this study contrasted sharply with EA children in each of the primary arch dimensions measured, namely, AL, AW, AP, and especially IDS (Figures 2 and 3). The clinically significant question arises as to the meaning of such differences. Perhaps the most meaningful clinical discussion of the differences in observed findings can be hypothesized, in a theoretical context, utilizing the biometrics of the respective primary dentitions as the baseline (Figures 4 and 5).

Theoretical Significance of Current Findings

Earlier investigations have reported interpopulation differences in the amount of transitional dental arch crowding and types of sagittal occlusal relationships observed in AA compared with EA children. Few investigative findings have been advanced that may shed light on the rationale for such differences. Because both dental arch crowding and sagittal occlusal relationships are thought to be influenced by AP measurements, a focus on the variable (IDS) that contributes most to interpopulation differences in AP is important. Although tooth material (ie, mesiodistal crown diameters) and AW measurements contributed to the

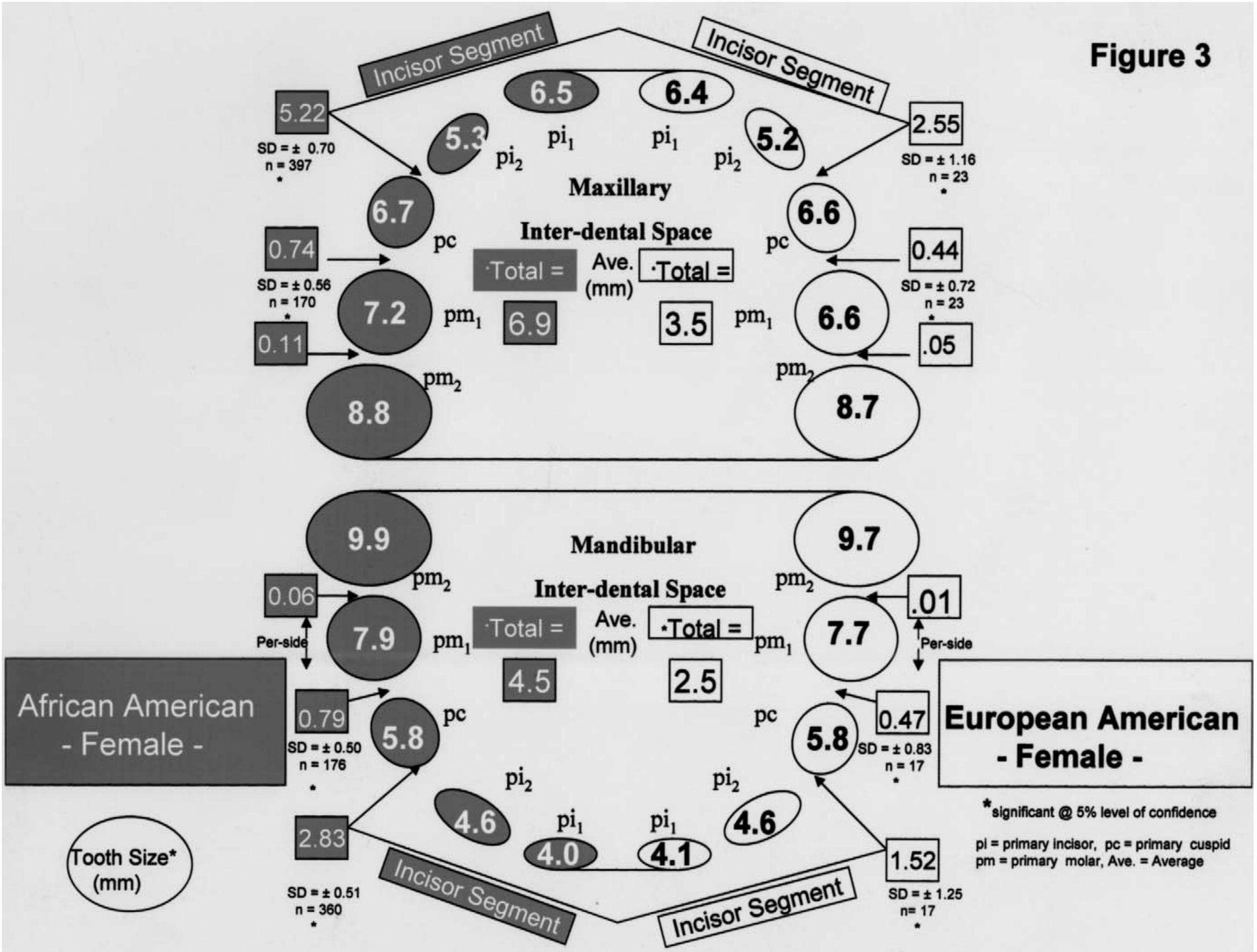

Figure 3. Statistical (mean, standard deviation) comparisons of interdental space in the primary dentition of African American and European American girls.

larger AP in AA compared with EA children, the amount of IDS was the most glaring difference, with possible clinical bearing on transitional dental arch crowding and sagittal occlusal adjustment outcomes.

Most often during the transitional development stage, the problem of space inadequacy manifests itself in the mandibular AP, and thus this discussion is oriented toward the mandible and limited to the male sex to avoid redundancy.

For a theoretical discussion regarding transitional mandibular dental AP development to approximate clinical reality, reliable estimates of at least five interrelated variables must be integrated: (1) primary[5,8] and permanent[5,15] tooth size (mesiodistal crown diameters), (2) amount of IDS,[4] (3) AP growth increments and timing,[4,5,14] (4) sequence and position of tooth eruption (exchange),[16] and (5) environmental conditions that may affect AP development.[14] The strength of the theoretical discussion rests on the usage of statistically derived measures of central tendency (averages) to approximate the reality of the five variables considered, and the respective sources have been cited for each.

A theoretical attempt at analyzing the mandibular segmental adequacy of AP and the contribution primary IDS may make during mandibular transitional development is depicted in Figures 4 (AA) and 5 (EA). Stages 1 to 5 depict the transitional exchange from primary and deciduous to permanent and succedaneous teeth. Developmentally, stages 1 to 3 can usually be regarded as negative leeway transitions and stages 4 and 5 can be regarded as positive leeway transitions. The underlying calculations describe the estimated segmental space status (deficit or excess) associated with each stage of development (see notes appended to Figures 4 and 5).

On average, the sum of the crown diameters of the 10 mandibular primary teeth is 2.30 mm larger than

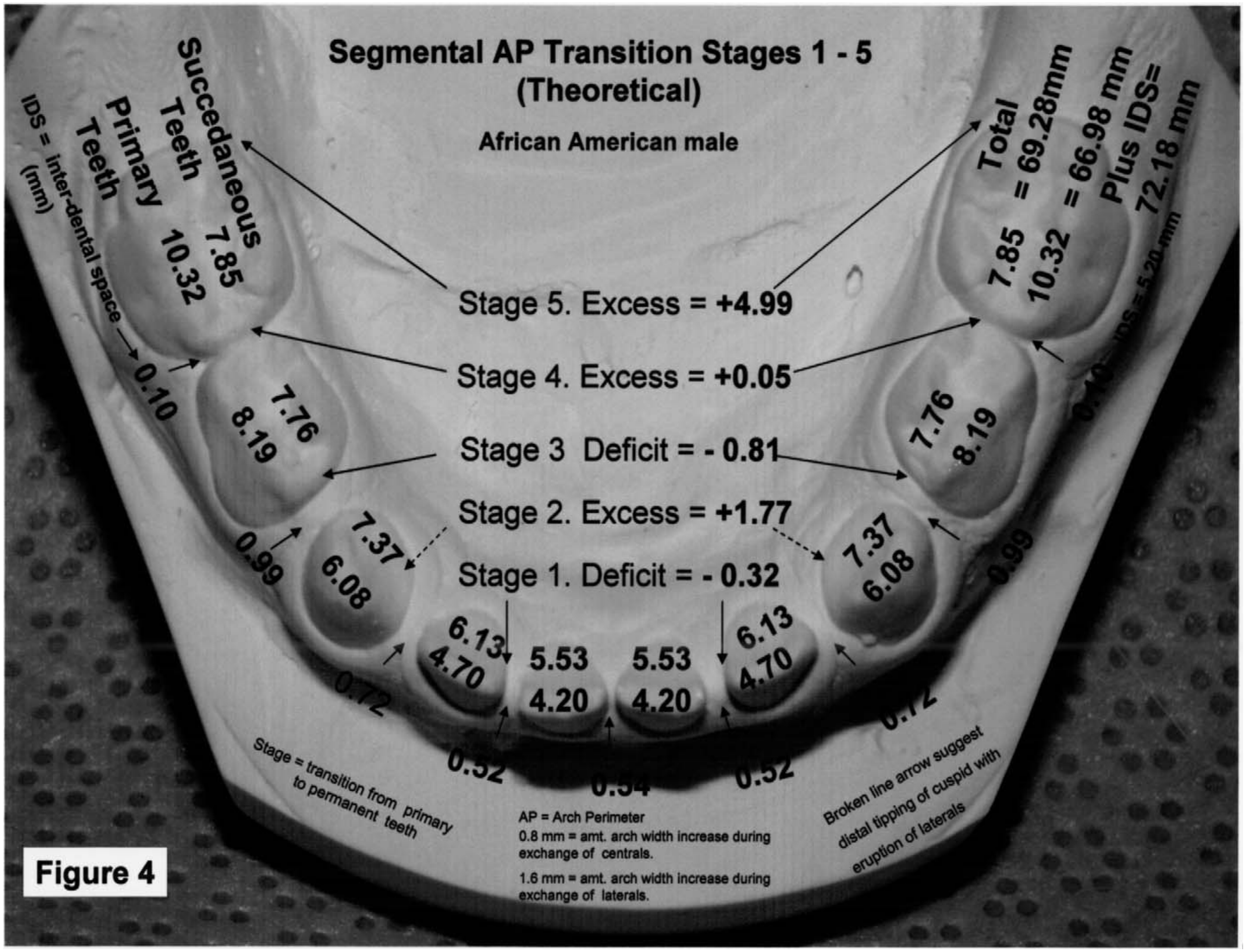

Figure 4. Theoretical mandibular segmental arch perimeter development in African American boys. Note: Calculations. Stage 1: Exchange of central incisors [(P = 11.06 − D = 8.4) + (1.5 IDS + 0.8 growth)] deficit = −0.32. Stage 2: Exchange of laterals: [(P = 12.26 − D = 9.4–0.32) + (3.4 IDS + 1.6 growth)] excess = +1.77. Stage 3: Exchange of cuspids: [(P = 14.74 − D = 12.16) + (1.77)] deficit = −0.81. Stage 4: Exchange of D1st molars: [(D = 16.38 − Pm_1 = 15.52) + (−0.81)] excess = +0.05. Stage 5: Exchange of D2nd molars: [(D = 20.64 − Pm_2 = 15.70) + (+4.94 + 0.05)] excess = +4.99. P indicates permanent; D, deciduous; IDS, interdental space; and Pm, premolars.

the sum of the 10 mandibular primary teeth in boys of AA descent (Figure 4). In boys of EA descent, the 10 mandibular primary teeth are, on average, 0.78 mm larger than the 10 mandibular primary teeth (Figure 5). Comparing only the tooth material ratios of the two populations, it appears that nature places approximately three times greater demand on the need for more primary IDS, transitional lateral jaw growth, or some combination thereof in children of AA descent—if AP adequacy is to be attained. Otherwise, theoretically, tooth material differences favors more crowding in AA children—just the opposite of the referred literature. Is there any correlation between succedaneous tooth size and IDS of primary dentitions?

Concomitant with the eruption of the primary incisors, and concurrent with the eruption of the primary canines, increments of lateral jaw growth changes and AP increases are registered.[14] The estimated contribution the lateral jaw growth changes added to AP measurements are reflected in Figures 4 (AA) and 5 (EA). These measurements are incorporated in the calculation stages 1 and 2. In children of EA descent, both lateral jaw growth changes and IDS serve to reduce transitional dental arch crowding in approximately equal amounts, with the greater reduction attributed to lateral jaw growth changes (Figure 5). In children of AA descent, just the opposite seems more plausible, with IDS allowing for a greater reduction in transitional incisor crowding and some relief for permanent canine eruption (Figure 4).

After the shedding of the primary incisors (centrals and laterals—stages 1 and 2, Figures 4 and 5), for all practical purposes IDS and lateral jaw growth will have expired. Yet there is one remaining negative leeway

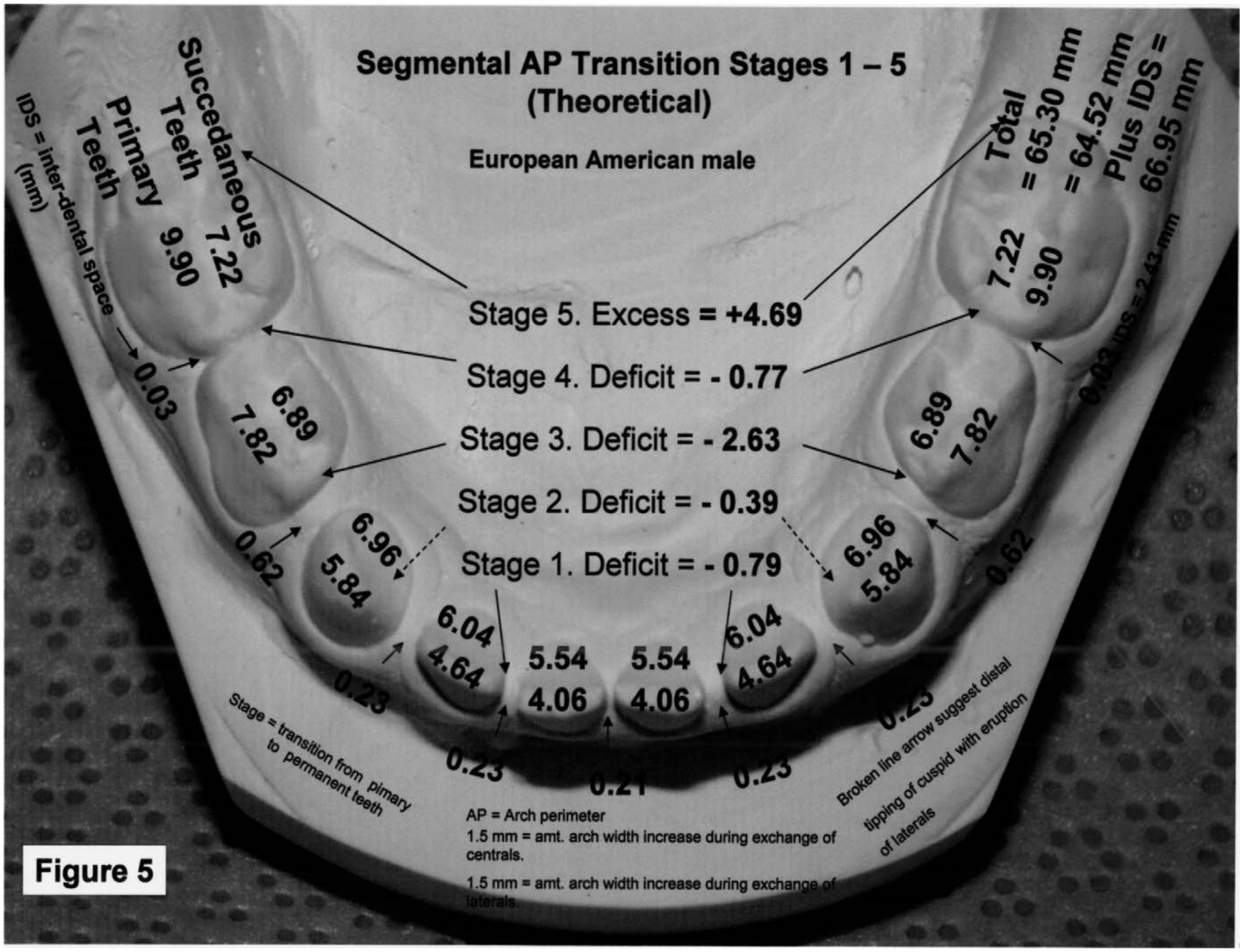

Figure 5. Theoretical mandibular segmental arch perimeter development in European American (EA) boys. Note: Calculations. Stage 1: Exchange of centrals: [(P = 11.08 − D = 8.12) + (0.67 IDS + 1.5 growth)] deficit = −0.79. Stage 2: Exchange of laterals: [(P = 12.08 − D = 9.28−0.79) + (1.70 IDS + 1.5 growth)] deficit = −0.39. Stage 3: Exchange of cuspids: [(P = 13.92 − D = 11.68) + (−0.39)] deficit = −2.63. Stage 4: Exchange of D1st molars [(D = 15.64 − Pm_1 = 13.78) + (−2.63)] deficit = −0.77. Stage 5: Exchange of D2nd molars: [(D = 19.80 − Pm_2 = 14.44) + (−0.77)] excess = +4.69. EA sources: IDS,[4] tooth size,[5] growth changes.[14] P indicates permanent; D, deciduous; IDS, interdental space; Pm, premolars.

space tooth size exchange to occur (stage 3, Figures 4 and 5). At this stage of development, according to measures of central tendency, AA boys show an estimated anterior segmental space excess of 1.77 mm compared with a segmental deficit of 0.39 mm for the EA boys. During the primary and permanent canine exchange, the anterior segmental deficit in EA boys approaches three times (−2.63 mm for EA boys vs −0.81 mm for AA boys) the segmental deficit of AA boys (stage 3, Figures 4 and 5). Theoretically, this observation also suggests the same ratio of utilization of positive leeway space (stages 4 and 5) to relieve the anterior segmental space deficits of the respective populations. Therefore, the author hypothesizes a greater severity of mandibular anterior segmental crowding in children of EA descent compared with children of AA descent largely because of quantitative differences in developmental patterns of IDS in the primary dentition. The minimum utilization needs for the positive leeway space (stages 4 and 5) to relieve anterior segmental deficits in AA children advantages a late mesial shift in a Class I and III occlusion direction.

The clinical research of Moorrees and Chadha[17] and Lundstrom[3] lend support to the theoretical argument of transitional stages 1 and 2. Moorrees and Chadha[17] reported average crowding of 1.6 mm in boys and 1.8 mm in girls of EA descent. Similar quantitative investigative studies in AA children have not been reported and are needed to test the hypotheses being advanced.

Limitations to the theorized transitional AP analyses are the inability to accurately individualize and proportionally quantify the dynamics of the five interrelated variables previously mentioned. Nevertheless, stages 1 and 2 (incisor transition, Figures 4 and 5) are the developmental periods that prompt recurring challenges regarding space management diagnosis and treatment planning in the early mixed dentition. It is hoped that the theoretical discussion and exercise will serve to remind the dental practitioner of the invaluable potential that developmental stages 4 and 5 (leeway spaces) may play in AP space management challenges.

CONCLUSIONS

- Significant gender dimorphism existed in AA children in all primary dental arch dimensions (AL, AW, AP) except for the mandibular AW.
- The total amount of IDS within the primary dental arches is approximately equal in AA boys and girls, but significant site-specific gender dimorphism exists (ie, boys showed larger primate spaces and girls showed large maxillary midline IDS).
- Each primary dental arch biometric measurement (AW, AL, AP, IDS) was significantly larger in AA children than in EA children.

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