Dental arch widths in the early and late permanent dentitions of a Nigerian population

[*]Aluko IA, [**]daCosta OO, [**]Isiekwe MC

[*]Private Practice, Manchester, UK, [**]Department of Child Dental Health,
College of Medicine, University of Lagos, Nigeria

***Correspondence: daCosta OO**

E-mail: rantidaCosta@metrong.com

Abstract

Objectives: This study was carried out in a Nigerian population to assess arch widths at two different stages of dentition, to observe the comparative changes which may occur. and to determine the presence or absence of sexual dimorphism in arch dimensions.
Method: The study population consisted of two groups of 150 subjects. Group 1 consisted of 75 males and 75 females aged 10-13 years (early permanent dentition); while Group 2 consisted of 75 males and 75 females aged 18-25 years (late permanent dentition). Measurements taken included maxillary and mandibular intercanine, interpremolar and intermolar widths for both groups.
Result: In the early permanent dentition stage, the mean maxillary intercanine, interpremolar and intermolar widths were 36.37mm, 45mm and 55.22mm respectively in males and 34.35mm, 42.62mm and 51.56mm respectively in females. All findings were significantly greater in males. In the mandibular arch, findings recorded in males were also significantly greater than females with the exception of the intercanine widths. In the late permanent dentition the mean maxillary intercanine, interpremolar and intermolar arch widths were 37.65mm, 46.25mm and 57.35mm respectively in males and 37.07mm, 45.21mm and 55.30mm respectively in females.
Conclusion: Comparative changes in arch widths between early and late permanent dentition stages were seen with greater increases in arch widths in the maxilla when compared to the mandible. Significant sexual dimorphism was observed in almost all dimensions measured.

Key Words: Dental arch widths, Nigerians

Introduction

Knowledge of dental arch widths in a population plays a key role in orthodontics. The size and shape of the arches will have considerable implications in orthodontics and treatment planning, affecting space available, dental aesthetics and stability of the dentition[1].
Differences in arch widths have been reported to exist between the races[2] and blacks have been shown to have larger arch widths than whites with less convergent middle and posterior arch segments[3,4]. Saudi and Egyptian arch widths have been reported to represent a median between Nigerian and British subjects[5]. In addition, transverse arch measurements have been found to be larger in males than females[6-9].
Factors reported to affect arch width include genetics[10], environment[11,12] and nutrition[13]. In addition, a secular trend towards a reduction in arch width has been shown in a number of studies[14,15].
Longitudinal studies in arch growth have shown an increase in arch width up to the age of 13 years, with very little significant growth after this period. Some studies even noted a slight decrease in arch size[9, 16].
Tooth size in Nigerians have been observed to be significantly larger than those of Caucasians[3,17,18]. However, studies on malocclusion in the Nigerian population show a high prevalence of spacing when compared with findings in Caucasians[19-21].
There has been a dearth of studies in the literature on arch widths in the Nigerian population and those available were carried out from a prosthetic point of view[3,22].
The purpose of this study was to assess arch widths at two different stages of dentition and to observe the comparative changes which occur. Also to determine the presence or absence of sexual dimorphism in arch dimension at each stage. This information will provide baseline data for practicing orthodontists in this region as well as orthodontists in other regions who manage patients from within this population.

Materials and method

This cross-sectional study was carried out in Lagos, the former capital of Nigeria located in the South-Western part of the country.

The Study Population

The study population consisted of two groups of 150 subjects. Group 1 consisted of 75 males and 75 females aged 10-13 years attending secondary schools in Lagos.
Group 2 consisted of 75 males and 75 females aged 18-25 years attending the College of Medicine, University of Lagos.

Criteria for study inclusion:

1. Intact permanent dentition
2. Normal A-P relationship between the maxillary and mandibular molars i.e. Angle's Class I occlusion
3. Absence of gross dental anomalies, crowding or spacing
4. No history of orthodontic treatment
5. No history of prolonged non-nutritive sucking habit

Alginate impressions of the maxillary and mandibular arches were taken using disposable trays of appropriate sizes to include all teeth present, the lingual and buccal sulci. Casts of each impression were then made using dental stone with special care taken to avoid air bubbles, breakage or defective models.

Parameters measured included:

1. Intercanine width – measured from cusp tip to cusp tip
2. Interpremolar width – measured from the buccal tips of contralateral first premolars.
3. Intermolar width – This was measured as the distance between the mesio-buccal cusp tips of the first permanent molars

These measurements were made in both the maxillary and mandibular arches **(Figure 1).**

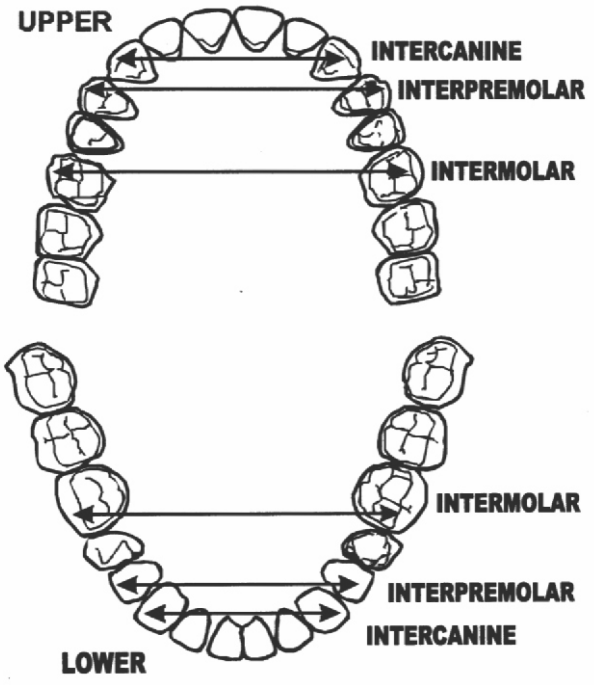

Figure 1. Arch width measurements

Measuring apparatus

The measurements were carried out on casts using sliding dial calipers calibrated to .05mm accuracy. All measurements were carried out by a single operator (I.A. A.)

Each model was assessed and measured a minimum of two times. Individual measurements that differed by more than 0.5mm were measured a third time to resolve the discrepancy. Thirty casts were randomly selected and measured. Measurements were repeated after 2 weeks in order to assess reliability of measurements and estimate intra-observer error, using DAHLBERG FORMULA: □ (??D^2/2N) Measurement error was found to be non-significant.

Data Analysis

Data obtained was analyzed using the EPI INFO version 6.2 software package.

Comparison between males and females was computed with the student t-test.

The critical level of statistical significance was pre-determined at a probability value of less than 0.05 ($p<0.05$).

Result

Age range in the early permanent dentition was 10-13 years with a mean age of 11.59 years in males and 12.1 years in females. In the late permanent dentition the age range was 18-25 years with a mean age of 21.6 years in both male and female subjects **(Table 1).**

Early Permanent Dentition

Mean maxillary intercanine, interpremolar and intermolar widths were 36.37mm, 45.91mm and 55.22mm respectively in males and 34.35mm, 42.62mm and 51.56mm respectively in females. All measurements were found to be significantly higher in males than females.

In the mandible, mean arch widths were also found to be significantly higher in males when compared to females with the exception of the intercanine widths, which were 28.32mm and 27.91mm respectively **(Table 2).**

Table 1. Age/sex distribution of sample populations

Age (years)	Male No.	%	Female No.	%	Total No.	%
Early permanent dentition						
10	17	11.3	5	3.3	22	7.3
11	17	11.3	8	5.3	25	8.3
12	21	14.0	35	23.3	56	18.7
13	20	13.3	27	18.0	47	15.7
Mean age(yrs)		11.59±		12.1±		
Late permanent dentition						
18	6	4.0	5	3.3	11	3.7
19	4	2.7	7	4.7	11	3.7
20	13	8.7	14	9.3	27	9.0
21	8	5.3	16	10.7	24	8.0
22	14	9.3	8	5.3	22	7.3
23	9	6.0	8	5.3	17	5.7
24	10	6.7	5	3.3	15	5.0
25	11	7.3	12	8.0	23	7.7
Mean **Total**	150	100	150	100	300	100

Late Permanent Dentition

(Table 3) shows the mean maxillary and mandibular intercanine, interpremolar and intermolar widths. Differences in mean arch width measurements between

Table 2. Maxillary and Mandibular arch widths in early permanent dentition

Arch width	Sex	Minimum (mm)	Maximum (mm)	Mean (mm)	p-value
Maxillary					
Intercanine	Male	33.70	38.55	36.37 ± 1.11	
	Female	30.35	38.50	34.35 ± 2.18	<100001*
Interpremolar	Male	42.00	49.50	45.91 ± 1.94	
	Female	37.00	47.75	42.62 ± 2.58	<100001*
Intermolar	Male	52.20	59.65	55.22 ± 1.81	
	Female	47.70	57.75	51.56 ± 2.69	<100001*
Mandibulay					
Intercanine	Male	24.40	31.30	28.32 ± 1.51	
	Female	24.40	30.90	27.91 ± 1.39	0.08565*
Interpremolar	Male	32.60	39.80	36.89 ± 1.71	
	Female	32.45	39.00	35.60 ± 1.81	<0.0001*
Intermolar	Male	42.50	50.10	47.79 ± 1.40	
	Female	42.90	49.90	46.15 ± 1.92	<0.0001*

*Significant

males and females was found to be statistically significant for intercanine, interpremolar and intermolar widths in the maxilla as well as intercanine and intermolar widths in the mandible being found to be greater in males. However the mandibular interpremolar width of 37.13mm (± 2.55) in males and 36.82mm (±1.35) in females was not found to be significant.

Comparative changes in arch width between early and late permanent dentition groups **(Table 4)** show that there were greater increases in arch widths in the maxilla when compared to the mandible. The maxillary intercanine width increased by 1.28mm (3.5%) in males, while females had a greater increase of 2.72mm (7.9%). Interpremolar arch width change was observed to be least in the maxilla of males, being 0.34mm (0.7%), whereas in females a 2.59mm (7.0%) difference was recorded. Maxillary intermolar width increased by 2.13mm (3.9%) in males and 3.74mm (7.3%) in females. In the mandible, increase in intercanine width was 0.73mm (2.6%) in males and 0.53mm (1.9%) in females, while an intermolar width increase of 0.83mm was the same in both males and females. Overall increase in arch width between the two stages of dentition was greater in females than in males.

Table 3. Maxillary and Mandibular arch widths in late permanent dentition

Arch width	Sex	Minimum (mm)	Maximum (mm)	Mean (mm)	S.D	p-value
Maxillary						
Intercanine	Male	33.20	41.15	37.65	1.87	
	Female	34.40	39.30	37.07	1.30	.0289*
Interpremolar	Male	42.60	49.10	46.25	1.95	
	Female	43.20	48.60	45.21	1.29	.0002*
Intermolar	Male	53.80	60.5	57.35	2.05	
	Female	53.15	58.30	55.30	1.24	<0.0001*
Mandibulay						
Intercanine	Male	26.50	32.05	29.05	1.57	
	Female	26.40	30.90	28.44	0.98	.0049*
Interpremolar	Male	29.65	42.00	37.13	2.55	
	Female	34.10	40.85	36.82	1.35	.3521
Intermolar	Male	42.75	52.95	48.62	2.35	
	Female	43.50	49.25	46.96	1.84	<0.0001*

*Significant

Table 4. Comparative changes in arch width between Early and Late permanent dentition groups

Arch width	Increase in mean arch width: Male		Female	
	mm	%	mm	%
Maxilla				
Intercanine	1.28	3.50	2.72	7.90
Interpremolar	0.34	0.70	2.59	7.00
Intermolar	2.13	3.90	3.74	7.30
Mandible				
Intercanine	0.73	2.60	0.53	1.90
Interpremolar	0.24	0.65	1.22	3.40
Intermolar	0.83	1.74	0.83	1.80

Discussion

In this study on transversal dental arch dimensions, the subjects selected for the study had clinically acceptable occlusion with no apparent facial disharmony. They exhibited Angle's Class I molar and canine relationship and had no history of prolonged sucking habits. None of the subjects had undergone any previous form of orthodontic treatment.

Males yielded larger means than females for all arch widths recorded with the magnitude of difference increasing antero-posteriorly. This sexual dimorphism was found to be significant for all transverse measurements with the exception of the mandibular intercanine width in the early permanent dentition and the mandibular interpremolar width in the late permanent dentition. A reduction in sexual dimorphism was also observed between early and late permanent dentition. Sexual dimorphism has also been noted in a number of previous studies[4,9,23,24]. However, in contrast, Ross-Powell and Harris[25] in their study of black American children reported an absence of significant sexual dimorphism. In corroboration with another study[26] it was also observed that sexual dimorphism was greater in the maxilla than the mandible. Sexual dimorphism may be related to the longer period of growth in males and also to their tendency to produce greater masticatory forces.

The results of findings in this study show that arch widths among this population at both stages of dentition studied are significantly greater than findings in comparable studies among Caucasians[9] as well as for those of black Americans[4,27] ($p<0.5$). A possible explanation for the dimorphism between Nigerians and black Americans may be the racial interbreeding among black Americans which would place a genetic component on the arch width. In

addition diet and environment would also play roles. While the Nigerian diet is rapidly changing, especially in the urban areas, the basic diet of this group of people is far less refined than that of the western world and a coarse diet has been shown to stimulate greater growth in arch width than a refined one by influencing the development of the masticatory system[13].

When comparing the findings of this study with that of a previous study carried out on a Nigerian population[3] the maxillary intercanine and intermolar widths were comparable with no significant differences in thee dimensions recorded in each study.

Width dimensional increase involves alveolar process growth almost totally since there is little skeletal increase at this time (none in the mandible) and it contributes little to dental arch change[28]. In this study, changes in arch width between the early and late permanent dentition groups were seen to be greater in the maxilla than the mandible for both males and females. The females exhibited greater changes in arch width dimensions when compared to males, thus reducing the degree of sexual dimorphism. The least arch width increase occurred in the mandibular premolar region in the male subjects. The latter finding concurs with that of Knott[24] whose finding from his longitudinal study showed that the least increase in width over a 20 year period occurred from the primary second deciduous molar to the second premolar.

The comparatively significant increases in most of the arch width dimensions assessed from the early to the late permanent dentition measured during this study are contrary to the findings of many longitudinal studies that have reported a minimal change in arch width after 13 years[6,16,23,25]. However, Harris[29] in his longitudinal study of adults reported that increases in arch width can be seen even into the 3rd and 4th decades of life.

When comparing the findings of this study (late permanent dentition stage) with those of an earlier study of a Nigerian population[3], the maxillary intercanine and intermolar widths were similar for both studied populations with no significant differences in these dimensions between the studies.

The clinical implications of arch width are of great importance in orthodontic therapy Burdi and Moyers[28] noted that the direction of vertical alveolar growth differs significantly in the maxilla and mandible. The maxillary alveolar processes diverge as the teeth erupt while the growth of the mandible is more parallel. This allows for a greater differential increase in the maxillary arch width during treatment. Strang[30] and Reidel[31] stated that mandibular intercanine and intermolar widths are uncompromising dimensions and should be maintained as originally presented to ensure long term stability. In agreement with the formers' findings, Bishara[9] and Little[32] recommended that the mandibular intercanine width should be used as a guide around which to build the eventual arch form. Due to the cross-sectional nature of this study increases in arch width between the two stages of dentition cannot be considered conclusive. This presented a severe limitation to this study. A longitudinal study of arch dimensions in the Nigerian population is needed to more accurately assess changes which occur with increase in age.

Conclusions

The results of this study have shown significant sexual dimorphism in almost all dimensions measured. The arch widths were also found to be significantly greater than those of comparable studies in both Caucasian and black American populations. The large arch dimensions recorded will help to explain the high prevalence of spacing often seen in this population.

References

1. Lee RT. Arch with and form: A review. Am J Orthod Dentofac Orthop 1999; 115: 305-315.
2. Lavelle CLB, Foster TD, Flinn RM. Dental arches in various ethnic groups. Angle Orthod 1971; 41: 293-299.
3. Mack PJ. Maxillary arch and central incisor dimensions in a Nigerian and British population sample. J Dent 1981; 9: 67-70.
4. Burris BG, Harris E. Maxillary arch size and shape in American blacks and whites. Angle Orthod 2000; 70: 297-302.
5. Younes SA. Maxillary arch dimensions in Saudi and Egyptian population sample. Am J Orthod 1984; 85: 83-88.
6. DeKock WH. Dental arch depth and width studied longitudinally from 12 years of age to adulthood. Am J Orthod 1972;62: 56-66.
7. Raberin M, Laumon B, Martin J, Brunner F. Dimensions and form of dental arches in subjects with normal occlusions Am J Orthod Dentofac Orthop 1993; 104: 67-72.
8. Harris EF. A longitudinal study of arch size and form in untreated adults. Am J Othod Dentofac Orthop 1997; 111: 419-427.
9. Bishara SE, Jakobsen JR, Treder J, Nowak A. Arch width changes from 6 weeks to 45 years of age. Am J Orthod Dentofac Orthop 1997; 111: 401-409.
10. Cassidy KM, Tolley EA. Genetic influence on dental arch form in orthodontic patients. Angle Orthod 1998; 68: 445-454.
11. Gross AM, Kellin GD, Franz D, Michas K, Walker M, Foster M et al. A longitudinal evaluation of open mouth posture and maxillary arch width in children. Angle Orthod 1994; 64: 419-424.
12. Ogaard B, Larsson E, Lindsten R. The effect of sucking habits, cohort sex, intercanine width and breast or bottle feeding on posterior crossbite in Norwegian and Swedish 3 year old children. Am J Orthod Dentofac Orthop 1994; 106: 161-166.
13. Beecher RM, Corrucini RS. The effects of dietary consistency on craniofacial and occlusal development in the rat. Angle Orthod 1981; 61-69.
14. Harper C. A comparison of medieval and modern dentitions. Eur J Orthod 1994; 16: 163-173.
15. Weiland FJ, Jonke E, Bantelean HP. Secular trends in malocclusion in Australian men. Eur J Orthod 1997; 19: 355-359.
16. Sillman JH. Dimensional changes of dental arches. Longitudinal study from birth to 25 years. Am J Orthod 1964; 50: 824-831.
17. Otuyemi OD, Noar JH. A comparison of crown size dimensions of a Nigerian and British population. Eur J Orthod 1996; 18: 623-628.

18. Adeyemi TA. Mesiodistal crown dimensions of permanent teeth in a Nigerian population FWACS thesis 1999.
19. daCosta OO. The prevalence of malocclusion among a population of northern Nigeria schoolchildren. West Afr J Med 1999; 18:91-96.
20. Otuyemi OD, Ogunyinka A, Dosunmu O, Cons NC, Jenny J. Malocclusion and orthodontic treatment need of secondary schools in Nigeria according to the Dental aesthetic Index (DAI). Int Dent J 1999; 49: 203-210.
21. Onyeaso CO. Prevalence of malocclusion among adolescents in Ibadan, Nigeria. Am J Orthod Dentofac Orthop 2004; 126: 604-607.
22. Bassey IE, Odunsi TA. Maxillary arch and palatal vault dimensions in a Southern Nigeria population. Afr Dent J 1988; 2: 31-37.
23. Knott VB, Beecher RM, Corrucini RS. The effects of dietary consistency on craniofacial and occlusal development in the rat. Angle Orthod 1981; 61-69.
24. Knott VB. Longitudinal study of dental arch widths at four stages of dentition. Angle Orthod 1972; 42: 387-394.
25. Ross-Powell RE, Harris EF. Growth of the anterior dental arch in black American children. A longitudinal study from 3 to 18 years of age. Am J Orthod Dentofac Orthop 2000; 118: 649-657.
26. Moyers RE, van der Linden PGM, Riolo ML et al. Standards of Human occlusal development monograph 5, Craniofacial Growth Series. Ann Abor, Michigan Center for Human growth and development, University of Michigan 1976.
27. Merz ML, Isaacson RJ, Germane N, Rubenstein LK. Tooth diameters and arch perimeters in a black and white population. Am J Orthod Dentofac Orthop 1991; 100: 53-58.
28. Burdi AR, Moyers RE. Development of the dentition and occlusion. In: Moyers RE. Handbook of Orthodontics Chapter 6. 4th ed. Chicago. Year Book Medical Publishers 1988.
29. Harris EF. A longitudinal study of arch size and form in untreated adults. Am J Orthod Dentofac Orthop 1997; 111: 419-427.
30. Strang R. The fallacy of denture expansion. Angle Orthod 1949; 19; 12-17.
31. Reidel R. Review of the retention problem. Angle Orthod 1960; 6: 179-199.
32. Little RM, Wallen TR, Reidel RA. Stability and relapse of the mandibular anterior alignment – first premolar extraction cases treated by traditional edgewise orthodontics. Am J Orthod 1981; 80: 349-365