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Anthropometry of Palpebro-helical Root Distance and Palpebro-lobular Insertion Distance among Nigerian Children Aged 3 – 18 Years

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Abstract
Anthropometric dimensions could be used as bases for the evaluation of the health status of children. This study was thus conducted due to significance of anthropometric parameters of the head and the face in forensic anthropology, medicine, surgery, paediatrics and medical imaging. This descriptive and cross-sectional study was carried out on 600 normal Nigerian children (males: n = 319; females: n = 281) to determine the mean and range of Palpebro-root and palpebro-lobular insertion distances. The mean palpebro-helical root distance ranged from 68.75±3.20 to 76.72±5.17 mm in males and 67.01±2.27 to 75.35±5.15 mm in females. The mean Palpebro-lobular insertion distance ranged between 66.70±2.82 and 76.53±4.93 mm in males and 65.52±2.57 and 74.79±5.45 mm in females. The findings revealed a progressive increase in the mean values of all the parameters in the children aged 3 – 18 years but no significant difference in the mean values between the sexes at different age groups.

Key words*: Anthropometric study; Palpebro-helical root distance; Palpebro-lobular insertion distance.*

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I. Introduction

The basic shape of the head and face is determined by the underlying craniofacial bones, cartilages buccal fat pads in the cheeks, and the muscles which contribute to the final contour of the head and face. Considerable facial growth changes occur during childhood as the paranasal sinuses develop and the permanent teeth erupt (Moore and Persaud, 1998).

Generally, the human body dimensions are influenced by ecological, biological or genetic, geographical, racial, gender and age factors (Okupe *et al*., 1984; Tuli *et al*., 1995; Mibodi and Frahani, 1996). Cephalometry or craniofacial anthropometry is one of the important parts of anthropometry in which dimensions of the head and face are measured. Cephalometry results can be of use in paediatrics, forensic medicine, plastic or corrective surgery and in diagnostic evaluation between patients with gross craniofacial disorders and the normal population (Farkas and Monro, 1987; Kolar and Salter, 1997; Kelly et al., 1999).

Morphometric dimensions can also be used to describe essential anatomical characteristics for use as design criteria in the development of protective equipment for the head and face. In medicine, quantitative comparisons of anthropometric data with patient measurements before and after surgery help in planning and assessment of cosmetic and reconstructive surgery (Farkas, 1994).

Age-related growth changes in the ear have been reported (Farkas *et al*., 1992; Azaria *et al*., 2003; Ekanem *et al*., 2010). Ear length matured in males at 13 years and in females at 12 years (Farkas *et al*., 1992). At maturation, the ear was reported to be shorter than that at 18 years. Based on these observations, age-related growth changes in the ear also contribute to variation in the palpebro-helical root and palpebro-lobular insertion distances (Farkas et al., 1992).

Random measurements generated according to the anthropometric profile of a population characterize the distinctive features of a likely face in a particular population (Ukoha et al., 2017; Okeke and Omaballa, 2020). In Nigeria children are likely to have varied palpebro-helical root distance and palpebro-lobular insertion distance probably due to the difference in the shape and size of the head or skull, as well as varied growth pattern. In the present study basic data of these measurements in relation to different age groups were undertaken. It is hoped that the result would be useful and important to clinicians as standard values for quantitative comparison of anthropometric data for paediatric patients. Secondly, a known range for Nigerians can help guide the design of products such as prosthesis, prescription glass frames, hearing aids and protective equipment such as face-shield and face-mask to fit most Nigerian children.

II. Materials and Methodology

Materials: The current study was carried out among 600 subjects, within the age range of 3 – 18 years. The subjects were apparently healthy and physically normal Nigerian children from primary and secondary schools with appropriate weight and height for age. Excluded from the study were children with hydrocephalus, frontal bossing, low or high set ears and abnormal inter-canthal distance. The school authority, participants and the parents of the subjects were informed about the procedure, and consent was given for the investigation. All the procedures were non-invasive.

All measurements were conducted with the use of digital callipers, calibrated in millimetres and centimetres. The measurements were recorded in relation to age and sex.

Methodology: The measurement of the palpebro-helical root and palpebro-lobular insertion distances were undertaken with the head of the subject aligned to the Frankfurt Horizontal Plane (Farkas, 1994; Kolar and Salter, 1997), such that all measurements were taken accurately with respect to this coordinate system (Figure 1).

The palpebro-helical root distance (PHD) was measured on the right and left sides of the face. Each distance was taken from the exocanthion (ex), which is the outer corner of the eye fissure where eyelids meet to the otobasion superius (obs), the highest point of attachment of the external ear to the head (that is, from ex – obs). The anterior tip of the callipers was placed on the exocanthion, while the posterior tip was made to lightly touch the otobasion superius. The reverse was carried out on the opposite side of the face.

The palpebro-lobular insertion distance (PLD) was also measured on the left and right sides of the face. The PL distance was taken from the exocanthion to the otobasion inferius (obi), the lowest point of attachment of the external ear to the head (that is, from ex – obi). During the measurement the anterior tip of the callipers was placed at the exocanthion (ex), with the posterior tip lightly touching the otobasion inferius (obi). The reverse was undertaken on the contralateral side of the face.

Statistical Analysis: The anthropometric data were analysed using one way analysis of variance (ANOVA) and Tukey-Kramer Multiple Comparisons Test. The results were given in form of mean ± standard deviation and tabulated as functions of the age group and sex. The probability value of less than 0.05 ($p<0.05$) was considered significant.

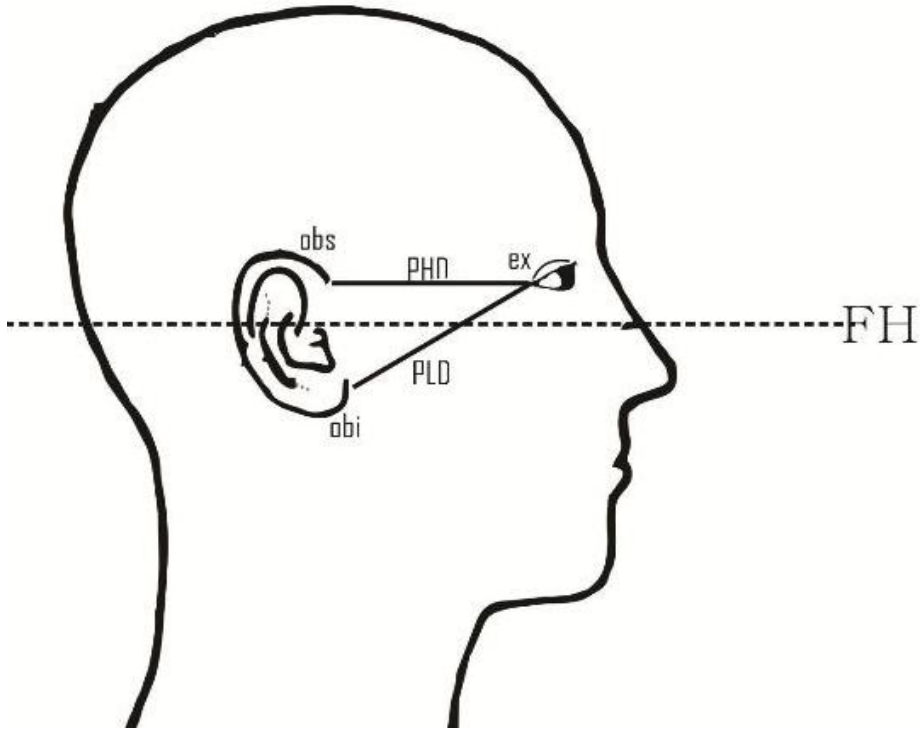

Figure 1: Measurement of Palpebro-helical root distance (PHD) and Palpebro-lobular insertion distance (PLD). Adapted from Kelly *et al.* (1999).

III. Results

Distribution of Samples According to Age Groups and Sex: In the current research, the total number of children studied was 600 volunteers. The cohort consisted of 319 males and 281 females all aged from 3 to 18 years. The results were further analysed according to the 3-6; 7-10; 11-14, and 15-18 age groups (Table 1).

Palpebro-helical Root (PH) Distance: The mean palpebro-helical root distance for the entire sample was 72.46±5.45 mm on the right side and 72.18±5.47 mm on the left side. Analysis of the right and left PH distance of the total sample showed no significant ($p>0.05$) difference between the mean values.

The mean PH distance in all the age groups as a function of sex were also computed (Tables 2-3). In the males, there was a minimal increase in the mean palpebro-helical root distance between age groups of 3-6 and 7-10 years. For instance, the right mean PH distance of 69.05±3.28 mm at 3-6 years to 69.70±4.06 mm at 7-10 years. However, the increments were higher, though not significant, between the older age groups. For example, the right mean PH distance of 73.36±4.82 mm at 11-14 years increased to 76.72±5.15 mm at 15-18 years. Similar changes in the mean values of the left palpebro-helical root distance were obtained.

In the females, there was a gradual increase in the right mean palpebro-helical root distance from 67.52±2.77 mm in the 3-6 year age group to 74.93±5.42 mm in the 15-18 year age group. Similar changes in the mean values of the left palpebro-helical root distance from the lowest age group 3-6 years to the highest age group of 15-18 years were also obtained for the females (Tables 2 and 3).

Palpebro-lobular Insertion (PL) Distance: The mean palpebro-lobular insertion distance of the right side from the entire sample population was 71.02±5.69 mm. However, the PL distance of the left side from all the children was 70.90±5.60 mm. The mean values between the right and left palpebro-lobular insertion distance for all the children and of all the age groups showed no significant difference ($p>0.05$).

The mean palpebro-lobular insertion distance in all the age groups studied of the different sexes were computed (Tables 2-3). In the males, minimal increase in the right mean PL distance of 67.70±2.82 mm at 3-6 years to 68.12±4.34 mm at 7-10 years was recorded. The right mean PL distance increased to 71.36±4.53 mm in the 11-14 years age group, and to 76.53±4.93 mm in the 15-18 years age group. In the females, the right mean PL distance showed increase from 65.52±2.57 mm; 66.06±3.51 mm; 71.65±5.15 mm to 74.79±5.45 mm in the different age groups understudy, respectively.

The result of the left mean palpebro-lobular insertion distance in both the male and female children showed similar pattern of insignificant, minimal increase with increase in the age groups under the current study (Tables 2 and 3). Combining the data from both male and female but as a function of the different considered age groups, the results maintained the insignificant, minimal increments in the mean palpebro-helical root distance and the palpebro-lobular insertion distance from the right and left sides of the face (Table 4).

The Tukey-Kramer Multiple Comparisons tests for relationships between the measured parameters are summarized in table 5. From the tests result there was no significant difference between the right and left mean palpebro-helical root distance or mean palpebro-lobular insertion distance ($p>0.05$). However, the test showed that there were significant differences ($p<0.001$) when the right mean palpebro-helical root distance was compared with the right mean palpebro-lobular insertion distance; as well as between the left mean palpebro-helical root distance and the left mean palpebro-lobular insertion distance.

Table 1: Distribution of Samples according to Age Groups and Gender

Age Group (Years)	No. of Subjects	Males	Females
3-6	57	26 (4.33%)	31 (5.17%)
7-10	130	52 (8.67%)	78 (13.00%)
11-14	268	161 (26.84%)	107 (17.83%)
15-18	145	80 (13.33%)	65 (10.83%)
Total	600	319 (53.17%)	281 (46.83%)

Table 2: The Mean and Standard Deviation of Palpebro-helical Root Distance and Palpebro-Lobular Insertion Distance of Nigerian Male Children

Age Group (Years)	No. of Subjects	Palpebro-helical Root Distance		P-value	Palpebro-lobular Insertion Distance		P-value
		Right (Mean ± SD mm)	Left (Mean ± SD mm)		Right (Mean ± SD mm)	Left (Mean ± SD mm)	
3-6	26	69.05 ± 3.28	68.75±3.20	0.74	67.22±3.27	66.70±2.82	0.53
7-10	52	69.70 ± 4.06	68.84±4.15	0.29	68.12±4.34	67.82±4.09	0.71
11-14	161	73.36 ±4.82	72.80±4.80	0.29	71.36±4.53	71.19±4.35	0.73
15-18	80	76.72 ± 5.15	76.72±5.17	0.99	76.53±4.93	76.18±4.95	0.65

Table 3: The Mean and Standard Deviation of Palpebro-helical Root Distance and Palpebro-lobular Insertion Distance of Nigerian Female Children

Age Group (Years)	No. of Subjects	Palpebro-helical Root Distance Right (Mean± SD mm)	Left (Mean ±SD mm)	P-value	Palpebro-lobular Insertion Distance Right (Mean ±SD mm)	Left (Mean ±SD mm)	P-value
3-6	31	67.52±2.77	67.01±2.27	0.43	65.52±2.57	65.53±2.48	0.98
7-10	78	69.12±4.62	68.87±4.30	0.72	66.06±3.51	66.16±3.45	0.86
11-14	107	72.45±5.14	72.28±5.12	0.81	71.65±5.15	71.69±5.22	0.99
15-18	65	74.93±5.42	75.35±5.15	0.64	74.79±5.45	74.89±5.37	0.91

Table 4: The Mean and Standard Deviation of Palpebro-helical Root Distance and Palpebro-lobular Insertion Distance of Combined Male and Female Nigerian Children

Age Groups (Years)	No. of Subjects	Palpebro-helical Root Distance Right (Mean±SD mm)	Left (Mean±SD mm)	P-value	Palpebro-lobular Insertion Distance Right (Mean±SD mm)	Left (Mean±SD mm)	P-value
3-6	57	68.22±3.08	67.80±2.85	0.46	66.30±3.00	66.06±2.68	0.66
7-10	130	69.35±4.40	68.86±4.22	0.35	66.88±3.98	66.82±3.79	0.89
11-14	268	72.99±4.96	72.59±4.93	0.34	71.47±4.78	71.37±4.71	0.79
15-18	145	75.92±5.33	76.11±5.19	0.75	75.75±5.23	75.60±5.17	0.80

Table 5: Tukey-Kramer Multiple Comparisons between the Right and Left Parameters in Combined Boys and Girls

Parameters	Right PHD	Right PLD	Left PHD	Left PLD
Right PHD	-	-	-	-
Right PLD	6.33^{***}	-	-	-
Left PHD	1.23^{ns}	5.10^{**}	-	-
Left PLD	6.85^{***}	0.52^{ns}	5.62^{***}	-

Key: *** = P<0.001; highly significant. ** = P<0.01; significant
ns= not significant
PHD = Palpebro-helical root distance
PLD = Palpebro-lobular insertion distance

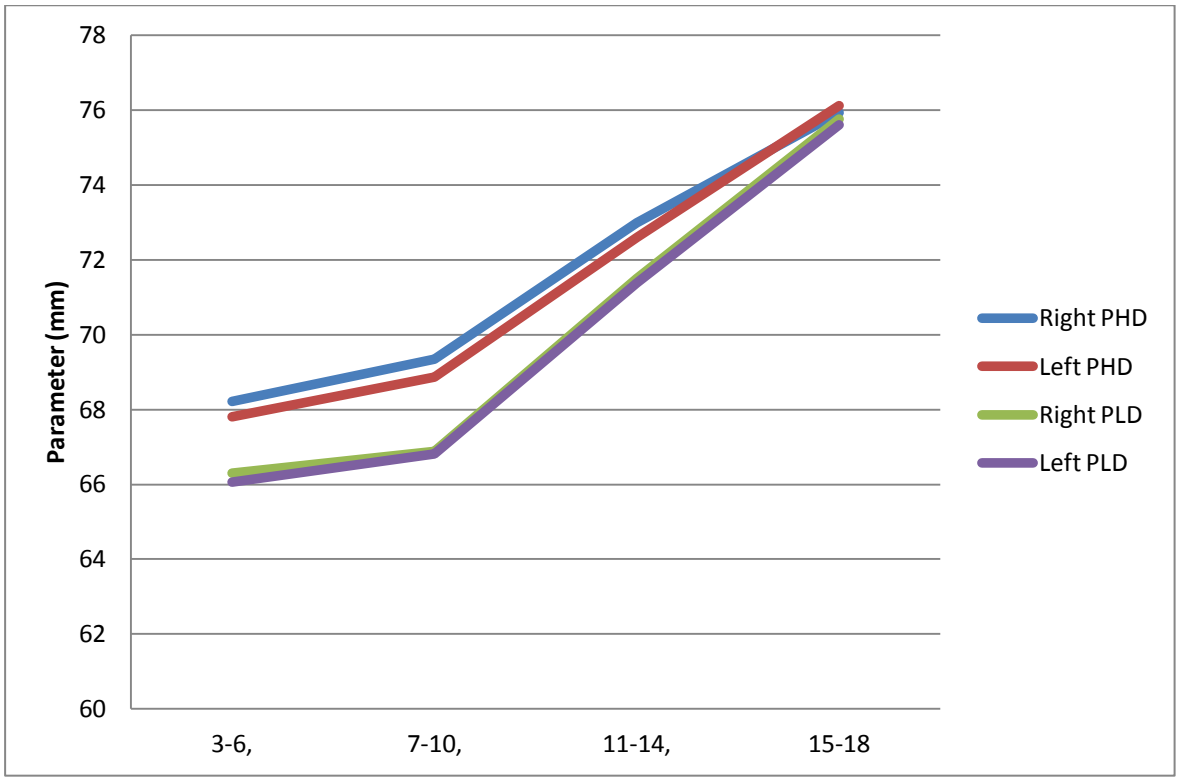

Figure 2: Graph of the mean Palpebro-helical root distance and Palpebro-lobular insertion distance in relation to age of combined male and female Nigerian children

IV. Discussion

A comprehensive evaluation of the craniofacial morphology should cover both external and internal aspects, but in the living such objective may only be obtained using computed tomography scan or magnetic resonance imaging (Iblher et al., 2008). However, due to the health risks associated with radiation exposure and the high cost implication of these techniques, they are difficult to employ in widespread data collection in normal subjects (Sforza and Ferrairio, 2006). Physical anthropometric measurements such as the present study can be used for validation of errors from imaging systems such as computed tomography (CT) measurements with digitizer (Kohn and Cheverud, 1992). In this study the physical anthropometric measurements are reliable, with error lower than 0.5 mm, when compared to a three-dimensional facial imaging measurement with errors higher than 1.5 mm (Aung et al., 1995; Cavankanti et al., 1996). Therefore, a non-invasive method was used for quantitative evaluation of craniofacial morphology in normal children.

The present study was conducted on the anthropometric measurements of the palpebro-helical root distance and palpebro-lobular insertion distance among school children in the metropolitan city of Maiduguri, North-eastern Nigeria, aged 3 to 18 years. Among the male subjects the mean Palpebro-helical root distance ranged from 68.75±3.20 mm to a maximum of 76.72±5.17 mm, while in the girls it ranged from 67.01±2.27 mm to a maximum of 75.35±5.15 mm. The mean Palpebro-lobular insertion distance ranged from 66.60±2.82 mm to 76.53±4.93 mm in the male children and 65.52±2.57 mm to 74.79±5.45 mm in the female children.

Analysis of the combined parameters from the male and female children showed that the mean Palpebro-helical root distance from the right side, increased from 68.22±3.08 mm at 3-6 years to 75.92±5.33 mm at the active age group of 15-18 years. On the other hand, the mean Palpebro-helical root distance from the left side among the study population increased from 67.80±2.85 mm during the 3-6 years to 76.11±5.19 mm at 15-18 years. There was also an increase in both the right and left Palpebro-lobular insertion distance with increasing age, from 66.06±2.68 mm at 3-6 years to 75.60±5.17 mm at 15-18 years. The results of the present study explain the fact that after childhood and adolescence different parts of the face still continue to change during adulthood, that is, even after the attainment of biological maturity (Ferraino *et al*., 2000; Akgul and Toygar, 2002; Leveque and Goubanova, 2004; Iblher *et al*., 2008; Sawyer *et al.*, 2009; Sforza *et al*., 2009).

Statistically there were no differences in the dimensions between the males and females; however differences between the age groups studied were noted (Figure 2). As the Nigerian child increased in age, the palpebro-helical root distance and palpebro-lobular insertion distance tends to increase slightly from the age of 3 to 10 years but with a sharp increase from the age of 11 to 18 years. Individual variation in the Palpebro-helical root distance and the Palpebro-lobular insertion distance could be associated with variation in shape and size of the skull, position of the eyes and ears on the skull which is a function of race and geographical zone, as well as varied growth pattern (Golalipour *et al.*, 2000).

Hereditary factors primarily affect the shape of the head. However, the environment has a secondary effect. The reaction to a given environment represents the interaction of the genotype of the given population with the environment (Jordan, 1976). The head shape is also affected by the factor of time or age (Nakashima, 1986). Therefore, the results from this study point to the possible effect of hereditary factored on the diversity of head and face shapes, as well as individual variations in the Palpebro-helical root distance and the Palpebro-lobular insertion distance. Additionally, gross morphological differences, such as obesity, and microscopic factors such as thinning of skin and muscle, increase in cutaneous fat and reduction in connective tissue fibres may contribute to variation in facial dimensions with age (See *et al.*, 2008; Penna *et al*., 2009).

The set of data generated in this study provide a useful standard for medico legal examinations in the geographical area investigated, which conclusively show that as Nigerian children grow, the palpebro-helical root distance and palpebro-lobular insertion distance tend to increase with the age.

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