

Foot Dimensions Of Igbo School Children And Adolescents In Enugu Urban

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ABSTRACT

Foot dimensions are useful for physical anthropology, forensic medicine and ergonomics. There is paucity of data on foot dimensions of children and adolescents in our environment hence the aim of this study was to establish standard values of foot dimensions in males and females of Igbo school children and adolescents in Enugu urban. This was a cross sectional study of the foot dimensions of one thousand four hundred and ninety eight subjects (807 males and 691 females) from the University of Nigeria Primary and Secondary Schools and Command Day Secondary School. The ages of the subjects ranged from 5-18 years. Their foot dimensions were measured and analyzed. In the 8 year-old and below, the foot length tended to be higher in males than in females but the difference was not statistically significant except in the 6 year-old. In the 9-10 year-old, the foot length was higher in females than in males but was significant only in the 10 year-old. From the 11 year-old, the foot length was higher in males than females. The mean values of foot length of males and females in our study were greater than most of the values for their Caucasian counterparts. The mean foot breadth of males and females increased with age. Males had significantly higher values at all ages except at ages 8, 9 and 10. At 11 years and above, the foot index of males was more than 34cm where as in females it was less than 34cm. Before the age of 11, the values of the foot index in females and males were more than 34cm and 35cm respectively. Our study has presented the foot dimensions of school children and adolescents in Enugu urban. The sexual dimorphism especially from the age of 13 may be useful for forensic medicine and ergonomics. Males have longer and broader feet than the females especially from the age of puberty. These findings are useful to shoe design and selection of shoe sizes. Males and females in the 16 year-old and above in our population had higher mean foot length than their Caucasian counterparts. This is probably one of the adaptations to a tropical climate.

KEYWORDS: Foot dimensions, sexual dimorphism, School children and Adolescents, Enugu urban.

Differences in the physical characteristics of individuals depend on the variations in their gene pools, the influence of their environment as well as their nutritional and health status. The relative contributions of these factors are not precisely known (Hiernaux 1968). Metheny (1939) had for a long time recognized ethnic and population differences in growth, physique and body proportions. Shetty (2004) and Abbassi (1998) documented significant differences in the growth rate of children from different populations due to differences in their health and nutritional status, as well as environmental and genetic makeup.

In virtually all populations, especially in developing societies, there has been a change in body size over generations. These secular trends in children's growth and development have been greatest in the 20th

century (Vaughan 1992).

The human foot is a highly complex multibone structure with 26 bones and numerous articulations. It is required to be stable for supporting body weight in standing and resilient for walking and accommodating to variations of surface on which it is placed. The normal human foot shows great individual variations in length and breadth in males and females (Ibinabo et al 2009).

Obikili et al. (2006) noted that the foot length of adult Nigerian males and females were 27.1 ± 1.3 cm and 25.1 ± 1.1 cm respectively, while the foot breadth were 9.9 ± 0.6 cm and 9.2 ± 0.5 cm respectively. Daniel et al (2005) and Kewal et al (2012) also noted that the foot dimension in adults were consistently higher in males than in females. Agnihotri et al. (2007) in their work

on determination of sex from the foot measurement noted that males had an average foot length of about 3cm more than the females. The foot breadth was about 1cm greater in males as compared to females. The finding is in line with the study conducted by Tyagi et al. (2004). The relationship between different body parts especially the limbs is used to establish sex and stature (Ozden et al. 2005, Sanli et al. 2005, Case et al 2007).

Knowledge of sexual dimorphism in foot shape is essential to a proper design of shoe shape. Hence, understanding the morphological and functional response to variations in foot pattern among ethnically different population necessitates a basic understanding of racial variation among populations using similar foot wear (Wunderlich et al 2001). It also plays vital role in medical rehabilitation and sport sciences (Chavan et al 2012).

In our environment, there is paucity of data on foot dimensions in children and adolescents. Obikili and Didia (2006) studied foot dimensions in young adult male and female Nigerians from the Eastern part of the country while Sexana (1981) studied foot length of adult Nigerians from the Northern part of the country. The aim of this study was to establish a reference standard in foot dimensions of Igbo school children and adolescents in Enugu urban.

MATERIALS AND METHODS

The study was a cross sectional survey of one thousand four hundred and ninety eight subjects (807 males and 691 females) within the age range of 5 to 18 years. The subjects were selected by simple random sampling from the University of Nigeria Primary and Secondary Schools and Command Day Secondary School. The foot dimensions were measured with a sliding caliper, with the foot placed on a horizontal flat surface, while the subject was standing.

The foot length was measured from the most posteriorly projecting point on the heel (akropodion) to the most anteriorly projecting toe (pternion), while the foot breadth was measured as the distance between the medial margin of the head of the first metatarsal and the lateral margin of the head of the fifth metatarsal.

The foot index was calculated as shown in the formula below.

Foot index = foot breadth/foot length x 100

To ensure accurate result all measurements were done by one person while sitting on a low chair to avoid error that could be caused by discomfort or individual difference. Apparently healthy looking school children and adolescents of Igbo origin in the urban centre of Enugu were included in the study while subjects with sickle cell disease, physically deformed and chronically ill looking were excluded from the study.

RESULTS

Table 1 shows the mean foot length of males and females by age. The mean foot length in both sexes increased significantly from the age of 5 to 12, thereafter the increase was no longer significant. In the 5 year-old to 8 year-old, foot length was higher in males than in females but the difference was not statistically significant except in the 6 year-old. In the 9 10 year-old, it was higher in females than in males but was significant only in the 10 year-old. From the 11 year-old it was higher in males than in females. But the sex difference was significant from 13 years. As highlighted in table 2 the mean foot breadth of males and females increased with age. Males had significantly higher values at all ages except at ages 8, 9 and 10. In the 10 year-old, the mean foot breadth was equal in both males and females.

Table 3 shows the mean foot index of males and females by age. The males had significantly higher values at all ages. From the age of 11, the foot index in males was more than 34cm, where as in the females it was less than 34cm. The comparative data on foot length of males and females were presented in table 4.

Table 1. Means and standard deviations of foot length of males and females by age.

Age	N	Mean±SD(cm)	N	Mean±SD(cm)	P-Value
5	56	18.2 ±1.2	61	18.0 ±1.2	0.290
6	65	19.5 ±1.1	67	19.0 ±1.1	0.010
7	46	20.3 ±1.2	58	20.0 ±1.3	0.220
8	42	21.5 ±1.4	61	21.2 ±1.6	0.300
9	72	22.1 ±1.3	61	22.4 ±1.3	0.190
10	57	22.7 ±1.4	41	23.4 ±1.3	0.010
11	45	24.0 ±1.5	61	23.9 ±1.3	0.770
12	76	24.4 ±1.5	61	24.4 ±1.2	0.930
13	67	25.6 ±1.5	45	24.3 ±1.3	0.000
14	41	26.4±1.1	20	24.9 ±1.3	0.000
15	48	27.0 ±1.5	40	24.7 ±1.4	0.000
16	41	26.7 ±1.1	43	24.5 ±1.3	0.000
17	55	26.7 ±1.5	38	24.8 ±1.1	0.000
18	94	26.9 ±1.4	34	24.5 ±1.5	0.000

Table 2. Means and standard deviations of foot breadth of males and females by age.

Age	Males		Female		P-Value
	N	Mean±SD(cm)	N	Mean±SD(cm)	
5	56	6.6±0.5	61	6.3±0.6	0.000
6	65	7.1±0.6	67	6.7±0.6	0.000
7	46	7.5±0.7	58	7.1±0.6	0.000
8	42	7.8±0.6	61	7.6±0.7	0.140
9	72	7.9±0.6	61	7.8±0.7	0.380
10	57	8.1±0.6	41	8.1±0.7	1.000
11	45	8.4±0.6	61	8.1±0.6	1.010
12	76	8.6±0.7	61	8.2±0.6	0.000
13	67	9.1±0.6	45	8.3±0.5	0.000
14	41	9.2±0.6	20	8.4±0.4	0.000
15	48	9.3±0.6	40	8.3±0.7	0.000
16	41	9.3±0.5	43	8.4±0.5	0.000
17	55	9.4±0.7	38	8.3±0.5	0.000
18	94	9.4±0.7	34	8.3±0.7	0.000

DISCUSSION

This study provided dimensions of foot length, breadth and index of Igbo school children and adolescents in Enugu urban. The small range for the standard deviation of foot dimensions in both sexes implies that the foot length and foot breadth are clustered around the mean values.

The males had significant higher mean values for foot breadth than the females except

in the 8-10 year-old where the difference was not significant. For the foot length, in the 12 year-old and below the sex difference was not significant except in the 10 year-old where the females have a significantly higher mean values than the males and in the 6 year-old where the reverse was the case. At the age of 13 years and above, the males had significantly higher values than the females. This sex difference started at the age of puberty. Our

Table 3. Mean and standard deviations of foot index of males and females by age.

Age	N	Mean±SD(cm)	N	Mean±SD(cm)	P-Value
5	56	36.3±0.9	61	35.0±1.0	0.000
6	65	36.4±1.1	67	35.3±1.2	0.000
7	46	36.9±1.0	58	35.5±0.9	0.000
8	42	36.3±0.9	61	35.8±1.1	0.010
9	72	35.7±1.2	61	34.8±1.1	0.000
10	57	35.7±1.0	41	34.6±0.8	0.000
11	45	35.0±0.8	61	33.9±1.2	0.000
12	76	35.2±1.2	61	33.6±1.1	0.000
13	67	34.5±1.1	45	33.5±1.0	0.000
14	41	34.7±1.0	20	33.7±0.7	0.000
15	48	34.4±1.2	40	33.6±0.9	0.000
16	41	34.1±0.9	43	33.6±0.9	0.010
17	55	35.2±1.0	38	33.5±0.8	0.000
18	94	34.9±1.3	34	33.9±0.8	0.000

Table 4: Comparative data on mean values of foot length by age and sex

	COUNTRY	PLACE	AUTHORS	AGE (YRS)		
				16	17	18
MALE						
	Britain	London	Tanner	25.9	26.1	26.0
	Poland	Warsaw	Wolanski 1962	26.0	26.0	26.2
	Bulgaria	Plovidiv	Stranisev et al. 1970	26.2	26.4	26.3
	Nigeria	Enugu	Obikili, 1991	27.0	27.2	27.2
	Canada		Census 2005	26.8	26.7	27.3
	India	Gujarat	Patel et al. 2007		23.8	24.4
	Nigeria	Enugu	Present study 2012	26.7	26.7	26.9
FEMALE						
	Britain	London	Tanner	23.6	23.7	23.7
	Poland	Warsaw	Wolanski 1962	24.0	23.8	23.7
	Bulgaria	Plovidiv	Stranisev et al. 1970	24.2	24.2	24.2
	Nigeria	Enugu	Obikili, 1991	25.5	25.3	25.2
	Canada		Census 2005	23.0	23.4	23.6
	India	Gujarat	Patel et al. 2007	-	22.1	22.3
	Nigeria	Enugu	Present study 2012	24.5	24.8	24.5

results are in keeping with the findings of Daniel et al (2005), Obikili et al (2006), Agnihotri et al (2007), Ibinabo et al (2009) and Kewal et al. (2012). The higher values in the females at 10 year-old could be attributed to the fact that females begin their adolescent growth spurt, which shoots up their growth rate at an earlier age than the males (Tanner 1961, Eveleth et al 1976, Didia et al 1986, Shamssain 1991).

In the 11 year-old and above, the foot index in males was more than 34cm, whereas in females it was less than 34cm. The value of 34 can be regarded as a deviation point for the determination of sex. Our finding corroborates the work of Obikili (1991) who noted that the foot index of males were more than that of the females but in contrary to report of Agnihotri et al (2007), which stated that females have higher values of foot index than the males.

The mean values of foot length of males and females in our study were larger than the Caucasians values. The result from Patel et al (2007) in India was lower than those obtained from other countries. This finding is generally in accord with the theoretical expectation that populations living in warm climates would have longer arms and legs than populations living in cold environments (Schreider 1975). He reported that tropical climate dwellers have longer limbs than temperate climate dwellers. Eveleth et al (1976) noted that Africans have the longest legs while the Asians have the shortest and that the values for Europeans are intermediate between the Africans and Asians. Shorter limbs and longer trunks are adaptive to cold environment as they reduce the surface area available for heat loss.

Clinical applications of foot dimensions have been documented by several authors. Gorman et al. (1997) in their study on the relationship between shoe size in women and mode of delivery noted that a woman with a small shoe size does not have a higher chance of being delivered by Caesarean section. Schultz et al. (1998) reported that many girls with Rett Syndrome have small feet for height while Rodier et al. (1997) noted that children with autism had smaller feet.

CONCLUSION

Our study has presented the foot dimensions of school children and adolescents in Enugu urban. The males have longer and broader foot dimensions than the females. This finding may be useful to shoe design and selection of shoe sizes. In both sexes, the 16 year-old and above have higher mean foot length than their Caucasian counterparts. This is probably one of the adaptations to a tropical climate. The sexual dimorphism in foot dimensions may be useful in physical anthropology, forensic medicine and ergonomics.

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