

Metacarpal Index in Nigerian Adults and Children.

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ABSTRACT

The metacarpal index (MI) is used in screening for patients with arachnodactyly especially Marfan's syndrome. It is a radiographic measure of the slenderness of the 2nd - 5th metacarpals, which was measured in a total of 608 Nigerians of which 55 (9%) were children and 553 (91%) were adults. The study shows that the MI increases steadily in children approaching the adult value at about the age of 9 years in females and 13 years in males coinciding with menarche and puberty respectively. A metacarpal index of up to 11 can be considered to be within normal limits for a Nigerian adult. In both children and adults, the MI was found to be higher in females than in males. In both sexes the metacarpal index for the left hand in the adult subjects is generally higher than that of the right hand, but in children, no significant difference is observed. As in other Africans, Nigerian adults have a higher MI than Caucasians.

KEYWORDS: Metacarpal index; Adults; Children, Nigerians.

INTRODUCTION

The metacarpal Index (MI) is a radiographic diagnostic indicator for measuring the relative slenderness of the metacarpal bones. It is defined as the average ratios of the length to the mid point width of the 2nd, 3rd, 4th and 5th metacarpals^{4, 2, 1}. Since Sinclair *et al* in 1960 described the technique of MI measurement, it has been widely used in the assessment of screening and diagnosis of arachnodactyly especially Marfan's syndrome. The accepted normal range is 5.4 - 7.9^{11, 1}. A value of 8.4 or higher has been considered an aid to the diagnosis of Marfan's syndrome¹⁰. Other conditions in which metacarpal index is increased include Turner's and Klinefelter's syndromes⁸.

Apart from the wide use of metacarpal index in the assessment of screening and diagnosis of arachnodactyly especially in Marfan's syndrome, its use have also been extended to other areas such as: (1) Prognostic indicator of Colles' fracture¹⁴, (2) Monitoring the growth and serial

changes of bone calcium content after renal transplantation in childhood⁶; and (3) in the monitoring of the rate of cortical bone loss after the age of 65 years⁵.

The purpose of this study therefore is not only to determine the baseline MI values for normal Nigerians but also to produce standard values for use in comparative studies of genetic abnormalities of the skeletal system affecting the hands.

MATERIALS AND METHODS

All the available Anteroposterior radiographs of both hands of patients from age 2 years and above that were done between 1990 to 1998 in the department of Radiology of the University College Hospital (UCH), Ibadan were reviewed. Those radiographs with abnormal findings were excluded. All radiographs were done at a film-focal distance of six meters and a kV range of 45 - 55, which is the standard practice in the Radiology Department of the University College Hospital, Ibadan. The films were then sorted out into name, age and sex as provided in the request cards. All those radiographs whose personal data could not be obtained from the request cards were excluded even though the radiographs might be normal.

In all, 608 pairs of hands of individuals of both sexes with the ages between 2 years to 99 years were studied.

METHOD OF MEASUREMENT

On each radiograph a total of 16 measurements (8 measurements each for the right and left hands) were made using a pair of divider and ruler to the nearest millimeter.

The lengths of the 2nd, 3rd, 4th and 5th metacarpals were measured. The lengths of the 2nd and 3rd metacarpals were measured from the tip of the metacarpal head to the apex of the notch at their base.

For the 4th and 5th metacarpals, the lengths were measured as the longest distance from the tip of the head to the most proximal part of the base. The width of each metacarpal was determined at the exact mid-point of its measured length. (Figures 1a and 1b).

The metacarpal index was then calculated by adding the lengths of the 2nd - 5th metacarpals divided by the sum of their widths.

Figure 1: Sample of an X-ray Radiograph used.

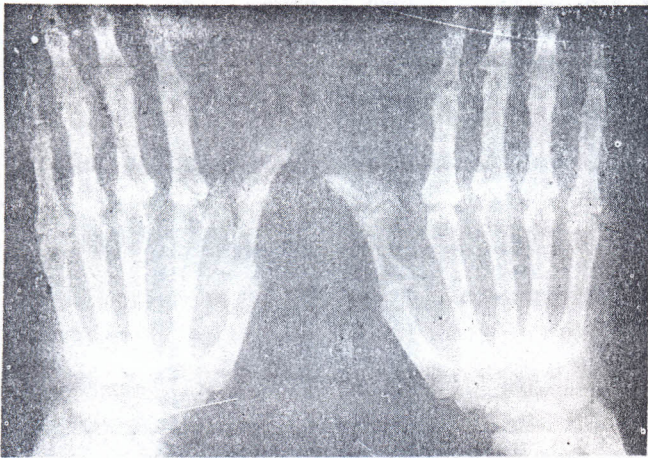


Figure 2: Site of Measurement of the Length and Width of Metacarpals 2nd, 3rd, 4th and 5th.

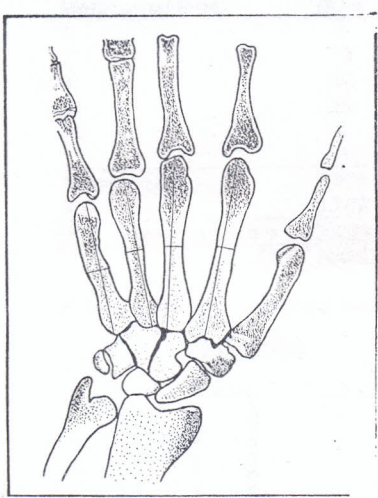


FIGURE 11: Site of measurement of the length and width of metacarpals 2nd, 3rd, 4th and 5th.

RESULTS

Table I shows the percentage sex distributions of the subjects examined. The study group was made up of a total of 305 males (50.2%) and 303 females (49.8%), out of which male children constituted 31 (5.1%), and female children were 24 (3.9%). The adult subjects in the study were made up of 274 males (45.1%) and 279 females (49.9%).

Table I: Distribution of the 608 Subjects Seen at the UCH, Ibadan by Age Category and Sex

	Male	% of Total	Female	% of Total	Total
Children	31 (7.9%)	5.1%	24 (10.2%)	3.9%	55 (9%)
Adults	274 (92.1%)	45.1%	279 (89.9%)	45.9%	553 (91%)
Total	305	50.2%	303	49.8%	608

Table II shows the age group distribution by sex, most of the subjects (both male and female) are in the 21 – 30 year age group. Figure III is the

histograms for the age groups distribution by sex, and also shows that majority of the subjects are in the 21 – 30 year age group.

Table ii: Age Distribution of Subjects by Sex

Age (Years)	Females	Males	Total
1 – 10	14	19	33
11 – 20	34	33	67
21 – 30	111	94	205
31 – 40	58	56	114
41 – 50	33	52	75
51 – 60	28	34	62
61 – 70	17	19	36
71 – 80	6	6	12
81 and above	2	2	4
Total	303	305	608

Table III shows the mean metacarpal index for the 55 children in the study, and the value ranges from 6 – 7.25 and 5 – 8.5 for the male and female right hands respectively. For the left hand the range is 7 – 7.5 and 5.5 – 8.5 for males and females respectively. Figure IV is the histogram for the age distribution of all the subjects with the mean age being 35 years within a standard deviation of 17.02.

Table IV shows the metacarpal index values for the male and female adults in the study. The metacarpal index for the left hand is between 6 and 11 with a mean of 7.821 and 8.095 for the male and female respectively. The metacarpal index for the right hand range from 6 to 10 and with a mean of 7.781 and 8.054 for the male and female respectively. Females generally have a higher metacarpal index value. Figure V is the graphical representation of the metacarpal index for the left and right hands of both sexes. It shows that the metacarpal index for females is clearly higher than that of their male counterparts. It also shows that there is a steady rise in the value of metacarpal index of both hands up to the age of thirteen years in both sexes after which there is minimal increase. In addition, the metacarpal index value for females begins to show a definite decline from about the age 70 years.

Figure VI is the graphic representation of metacarpal index values for the adult subjects; and peaks at the metacarpal index of 8 for both hands. There are more males than females in this category for the left hand; whereas the number of subjects is more or less the same for the right hand. Table V is the mean metacarpal index values of the children in this study compared with that of previous studies.

Table VI shows comparison of metacarpal index values in adult Nigerians in this study compared with that from other parts of the world. The metacarpal index values for Nigerian adults fall within the same range as that of other studies in populations of African decent.

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Table III: Metacarpal Index for 55 Children (Age 16 Years and Less) Seen at the U.C.H., Ibadan

Age in Years	RIGHT HAND						LEFT HAND					
	Males			Females			Males			Females		
	No	Mean	SD	No	Mean	SD	No	Mean	SD	No	Mean	SD
2	1	6.0	-	-	-	-	1	7.0	-	-	-	-
3	3	5.0	-	2	5.0	1.41	3	5.0	-	2	5.5	0.71
4	5	5.6	0.55	4	6.0	0.82	5	5.4	0.55	4	6.0	0.86
5	2	6.0	-	1	6.0	-	2	6.0	-	1	5.0	-
6	-	-	-	2	7.5	0.71	-	-	-	2	7.0	-
7	-	-	-	1	9.0	-	-	-	-	1	8.0	-
8	2	6.5	0.71	1	6.0	-	2	6.5	0.71	1	6.0	-
9	3	6.33	1.53	1	8.0	-	3	6.33	1.53	1	8.0	-
10	3	7.0	-	2	7.0	-	3	7.33	0.58	2	7.0	-
11	1	7.0	-	-	-	-	1	7.0	-	-	-	-
12	1	7.0	-	3	7.0	-	1	7.0	-	3	7.0	-
13	1	8.0	-	-	-	-	1	8.0	-	-	-	-
14	1	8.0	-	2	8.5	0.71	1	8.0	-	2	8.5	0.71
15	4	8.0	1.41	3	7.67	0.58	4	8.5	0.58	3	7.67	0.58
16	4	7.25	0.5	2	8.5	0.71	4	7.5	0.58	2	8.5	0.71

Note: All studies reported the metacarpal index of the Left Hand.

Table IV: Relationship between Metacarpal Index and Sex in Adult Nigerians seen at the U.C.H., Ibadan in 1999.

Metacarpal Index	Male	Female	Metacarpal Index	Male	Female
6	4	2	6	4	1
7	79	63	7	85	57
8	157	123	8	156	149
9	28	82	9	25	68
10	5	4	10	4	3
11	0	1	Mean	7.781	8.054
Mean	7.821	8.095	S.D.	0.637	0.711
S.D.	0.702	0.8	T-test = 4.58, p = 0.000006 (statistical significant)		

T-test = 4.26, p = 0.000024 (statistical significant)

LEFT HAND

RIGHT HAND

Figure 3: Graphic Representation of the Age Distribution by Sex

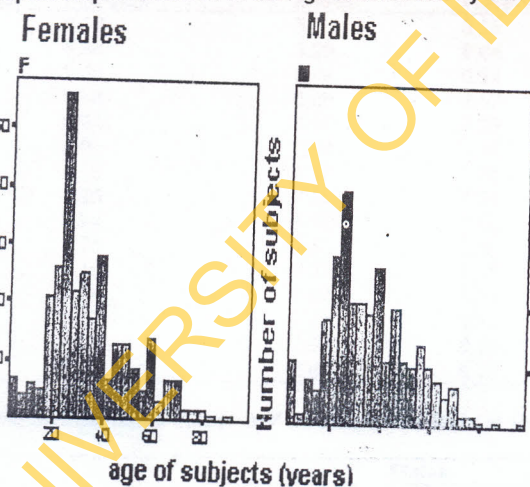
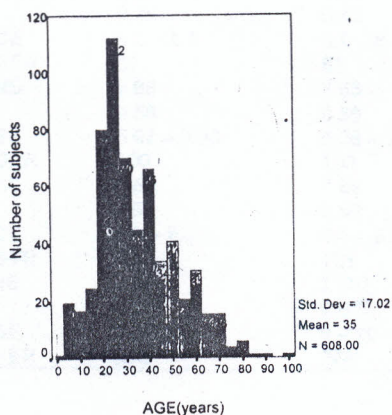


Figure 4: Age Distribution of 608 Subjects Seen at the UCH, Ibadan in 1999



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Figure 5: Metacarpal Index by Age In 608 Nigerians Seen at the UCH, Ibadan, (1999)

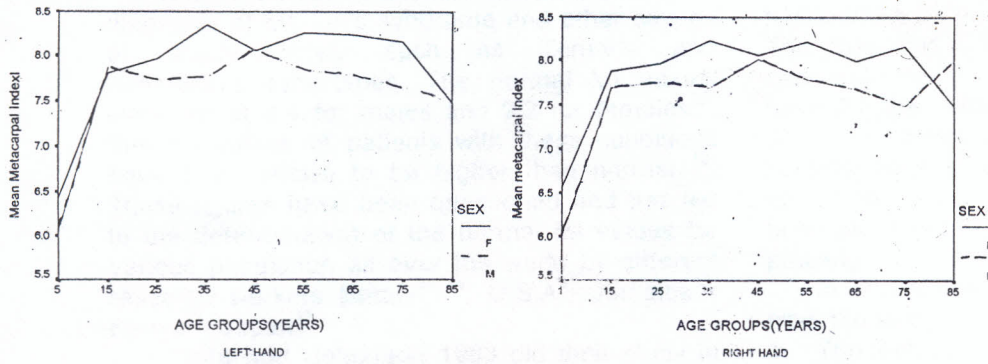


Figure 6: Graphic Representation of the Metacarpal Index of Nigerian Adults Seen at the UCH, Ibadan by Sex

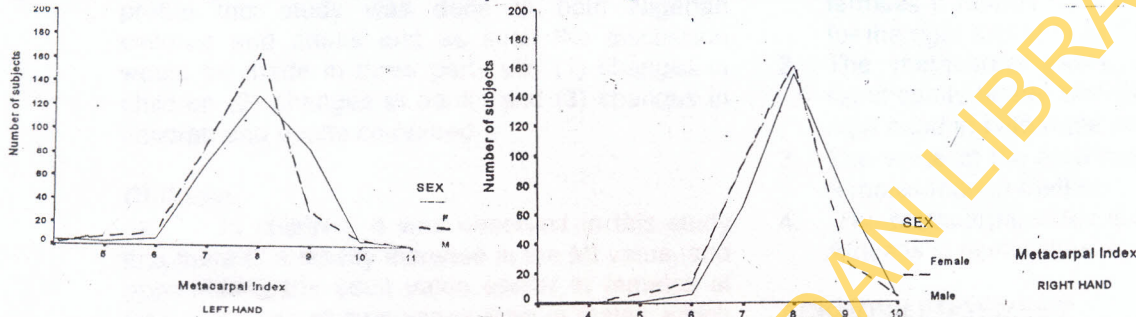


Table V: Comparison of the Metacarpal Index Values of Children under 17 Years seen at the UCH, Ibadan with Results from Previous Studies

AGE (Years)	Odita and Ugbodaga, (1983), Males	Odita and Ugbodaga, (1983), Females	Walker, (1979), Males	Walker, (1979), Females	Rand et al, (1980) combined	Current study, Males	Current study, Females
2	6.26	6.13	5.9	6.15	5.5	7	-
3	5.76	6.84	6.29	6.64	5.91	5	5.5
4	6.98	7.03	6.48	6.94	6.58	5.4	6
5	6.88	7.66	6.85	7.17	6.82	6	5
6	6.74	6.84	6.97	7.39	7.33	-	7
7	7.16	8.09	7.15	7.48	7.15	-	8
8	7.71	8.02	7.12	7.74	7.66	6.5	6.0
9	7.8	7.23	7.29	7.71	7.91	6.33	8
10	7.05	7.74	7.19	7.93	8	7.33	7
11	7.36	7.73	7.42	7.95	7.85	7	-
12	7.19	7.16	7.51	8.15	7.92	7	7
13	7.23	7.74	7.67	8.11	7.79	8	-
14	7.61	8.32	7.83	8.12	7.86	8	8.5
15	7.5	7.75	7.63	8.23	8	8.5	7.67
16	7.71	7.95	7.83	8.34	7.97	7.5	8.5

Table VI: Comparison of Metacarpal Index Values in Adult Nigerians Seen at the UCH, Ibadan in 1999 with Results from other Studies

		Males		Females	
		Left	Right	Left	Right
CANADA <i>Parish, (1966)</i>	MEANS	7.02	6.86	7.78	7.60
	S.D.	0.49	0.45	0.49	0.52
	RANGE	6.0 – 8.5	5.9 – 8.1	6.8 – 9.0	6.3 – 8.9
	NUMBER	51	51	82	82
JAMAICA <i>Walker and Ashcroft, (1978)</i>	MEANS	7.88	7.53	8.17	8.09
	S.D.	0.58	0.58	0.64	0.60
	RANGE	6.67 – 9.96	6.28 – 9.42	6.43 – 9.95	6.77 – 9.46
	NUMBER	100	100	100	100
KENYA <i>Wuchiria, Calder and Palmer, (1982)</i>	MEANS	7.89	7.69	8.30	8.22
	S.D.	0.57	0.59	0.61	0.55
	RANGE	5.9 – 9.1	6.4 – 9.0	6.6 – 9.7	7.3 – 9.2
	NUMBER	132	123	54	37
NIGERIA	MEANS	7.821	7.781	8.095	8.054
	S.D.	0.702	0.687	0.8	0.711
	RANGE	6 – 10	6 – 10	6 – 11	6 – 10
	NUMBER	273	274	275	278

DISCUSSION

The MI is a useful clinical measurement for the diagnosis of Marfan's syndrome and other causes of arachnodactyly such as Turner's and Klinefelter's syndromes. The normal MI values were put at 8.4 for males and 9.2 for females¹⁰. The MI values of patients with these conditions have been shown to be higher than normal¹⁰. These figures have been questioned and has led to the determination of the normal MI values for various population all over the world by different research workers Britain^{8, 13}; U.S.A⁹; Jamaica¹²; Kenya¹¹; Japan¹⁵.

Odita and Ugbodaga 1983 did their study in Nigerian children only. In order to have a wider profile this study was done in both Nigerian children and adults and as such the discussion would be made in three parts viz. (1) changes in children (2) changes in adults and (3) changes in children and adults combined.

Children:

(i) In children, it was observed in this study that there is a steady increase in the MI value, and approaching the adult value earlier in females at (about the age of nine years) than in males, which attained at about the age of thirteen years. This is similar to the findings of the previous workers^{12, 9, 7}. However in none of the above studies was the sex of the children stated, therefore, it could not be deduced if the MI value was higher in females than in males especially as they approach the adult age as observed in this study. Although it has been stated that the adult value of MI is approached at an earlier age (of about nine years) in Nigerian children than the in Caucasian children, who approach the adult value at about the age of thirteen⁷. From this study it could be postulated that at about the age of nine years when the female mean MI value approach that of the adult coincides with the age at which menarche is attained and thirteen years in males coincides with pubertal age. Therefore this study does not entirely agree with the above view of Odita and Ugbodaga. However the system of selection may have influenced the results.

(ii) In adults, the mean MI value for the left hand is significantly higher ($p = 0.000024$ and 0.000006 for the left and right hands respectively) statistically than that of the right hand; although the disparity is higher in females. This is in agreement with the findings of earlier workers-U.K^{13, 8}, Jamaica¹², Kenya¹¹, but in the Japanese however there is no significant difference between the mean MI values of both hands¹⁵. The cause of this difference in the mean value of MI between the bones of the two hands is uncertain, but it has

been suggested that the difference might be related to the amount of manual work performed by each hand⁸. In this study however, left or right-handedness of the subjects were not ascertained. This study has further corroborated the findings in earlier studies^{12, 11}, that people of African descent have a higher mean MI than the Caucasians.

(iii) In older children and adults the female subjects have a higher mean MI than males when each hand is considered separately, and this has been attributed to the relative slenderness of their phalanges^{8, 13}.

In conclusion the following can be deduced from the study:

1. The metacarpal index for Nigerian males range between 6 – 10 for both hands while for females it ranges between 6 – 10 and 6 – 11 for the right and left hand respectively.
2. The metacarpal index of the left hand is significantly higher statistically than that of the right hand in both male and female subjects.
3. The value of the metacarpal index is higher in females than in males.
4. The metacarpal index in Nigerians as in other Africans is higher than in the Caucasians.

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