Estimation of Height and weight from the Lengths of Second and Fourth Digits in Nigerians

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Citation

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Abstract

Estimation of height and weight from different body parts have received great attention in anthropology and forensic sciences. This study was designed to investigate the ability of estimating stature from second (2D) and fourth (4D) digit lengths. Subjects were students and staff of the Ahmadu Bello University, Zaria, males n= 650 (mean age 20.64 ± 6.94) and females n= 435 (mean age 18.73 ± 6.29) participated in the study after given informed consent. Measurements of 2D and 4D lengths, height and weight were made following standard protocols. The result showed that height can be predicted from the lengths of right and left 2D and 4D significantly ($P < 0.001$) and . This study has demonstrated that body parts such as finger lengths can be utilized for the estimation of height and weight.

INTRODUCTION

Relationship that exist between different part of the body and height had been of great interest to anthropologists, forensic and medical scientists for many years [123]. This is because of the increase in the number of catastrophic events causing mass deaths from natural or man made errors. Such disasters like flooding, tsunamis, earthquakes, plane crashes, train crashes , terrorist attacks usually requires the identification of victims from fragmentary and dismembered human remains [123]. Earlier reports have shown that relationship exists between stature and hand length and foot length [2345], stature and shoe dimension [67] stature, tibial length and malleolar breadth [8]. This study was designed to investigate the relationship between 2D and 4D lengths to height and weight.

MATERIALS AND METHODS

SUBJECTS AND ANTHROPOMETRY

2D and 4D lengths measurements were obtained from 1082 subjects (males n = 651 and females n = 431) who are staff and students of the Ahmadu Bello University, Zaria, Nigeria, after given informed consent with mean age of 20.64 ± 6.94 for males, and 18.73 ± 6.29 for females. 2D and 4D lengths were measured on the ventral surface of the hand from the basal crease of the digit to the tip of the second and fourth digits in both right and left hands using an Avenger digital caliper (MicroMak, USA) measuring to 0.01mm as described by Manning et al [9]. 2D and 4D lengths data on subjects were classified on the basis of their sex and subjected to statistical analysis. Height and weight were measured following standard protocols as described by Lohman et al [10].

STATISTICAL ANALYSES

Data were expressed as mean ± standard deviation (SD). Student's t-test was used to test for the difference in height, weight, 2D, 4D between female and males. Linear and multiple linear regressions were applied to test the predictive ability of 2D and 4D on height and weight. Statistical significant difference was deemed acceptable at $P < 0.05$. SigmaStat 2.0 for Windows (Systat Inc., Point Richmond, CA) was used for the statistical analyses.

RESULTS

Table 1 presents the sex differences in the parameters considered in the study. In all, the males were significantly ($P<0.001$) higher the females. Tables 2 and 3 present the correlation coefficients, prediction equations and probabilities of 2D and 4D in males and females respectively. The regression equations showed significant ($P <0.001$) ability to predict right 2D from left 2D, right 4D from left 4D and vice versa.

Table 4 presents the regression of height on 2D and 4D in males and females. Height could be predicted in males with significant assurance from right 2D and left 4D. In females a different prediction probability was obtained, height be

predicted with significant probability only in left 2D.

Multivariate regression analyses of second and fourth digit lengths are presented in Table 5. Digit lengths are highly predictive of height in both males and females (P<0.001) but weight showed lower predictive significance in males and females (P=0.02 and P=0.04) respectively.

Figure 1

Table 1: Descriptive characteristics of parameters studied in males and females. Values in parenthesis are minimum to maximum.

	Males (n= 651) Mean ± SD	Females (n= 431) Mean ± SD	t	P
Height (cm)	173.31 ± 7.06 (150.00-200.00)	161.62 ± 6.21 (144.50-179)	27.96	<0.001
Weight (kg)	65.78 ± 9.28 (46.00-120)	56.59 ± 9.28 (40.00-96.00)	15.96	<0.001
Right 2D (mm)	73.54 ± 6.2557 (57.66-95.30)	69.95 ± 4.73 (55.31-81.55)	9.84	<0.001
Right 4D (mm)	77.51 ± 5.02 (59.81-92.20)	72.42 ± 4.68 (54.80-85.50)	16.79	<0.001
Left 2D (mm)	74.78 ± 5.02 (58.48-96.70)	70.71 ± 4.44 (58.50-82.92)	13.65	<0.001
Left 4D (mm)	77.87 ± 5.15 (60.13-98.90)	72.77 ± 4.56 (59.20-87.06)	16.68	<0.001

Figure 2

Table 2: Predictive equation of height from right and left second and fourth digit lengths in males and females.

Equations	SEE	t	r	r^2	P
Males (n= 650)					
Ht= 142.191 + (0.423 x Right 2D)	6.51	49.12	0.39	0.15	<0.001
Ht= 119.202 + (0.698 x Right 4D)	6.13	31.99	0.50	0.25	<0.001
Ht= 123.495 + (0.666 x Left 2D)	6.22	33.87	0.47	0.22	<0.001
Ht= 118.28 + (0.707 x Left 4D)	6.05	32.91	0.52	0.27	<0.001
Females (n= 431)					
Ht= 125.402+ (0.518 x Right 2D)	5.71	30.73	0.40	0.16	<0.001
Ht= 122.323 + (0.543 x Right 4D)	5.67	28.86	0.41	0.17	<0.001
Ht= 114.891 + (0.661 x Left 2D)	5.41	27.29	0.47	0.22	<0.001
Ht= 121.504 + (0.551 x Left 4D)	5.68	27.72	0.41	0.16	<0.001

Figure 3

Table 3: Regression equations of 2D and 4D in males (n = 650)

Equations	SEE	t	r	r2	P
Right 2D= 13.134 + (0.783 x Right 4D)	3.11	6.94	0.77	0.59	<0.001
Right 2D= 9.199 + (0.863 x Left 2D)	2.56	6.42	0.86	0.74	<0.001
Right 4D= 19.515 + (0.786 + Right 2D)	3.21	10.80	0.59	0.34	<0.001
Right 4D= 9.015 + (0.880 x Left 4D)	2.45	7.07	0.89	0.80	<0.001
Left 2D= 11.134 + (0.862 x Right 2D)	2.56	7.49	0.86	0.74	<0.001
Left 2D=13.493 + (0.787 x Left 4D)	2.95	7.69	0.81	0.65	<0.001
Left 4D=15.761 + (0.831x Left 2D)	3.04	8.86	0.81	0.65	<0.001
Left 4D= 5.887 + (0.929 x Right 4D)	2.21	4.39	0.90	0.82	<0.001

Figure 4

Table 4: Prediction equations of 2D and 4D in females (n= 431)

Equations	SEE	t	r	r^2	P
Right 2D = 25.272 + (0.613 x Right 4D)	3.37	7.36	0.70	0.49	<0.001
Right 2D = 10.026 + (0.845 x Left 2D)	2.44	2.89	0.86	0.73	<0.01
Right 4D = 23.809 + (0.695 x Right 2D)	3.34	9.99	0.70	0.49	<0.00
Right 4D = 8.155 + (0.833 x Left 4D)	2.39	4.45	0.86	0.74	<0.001
Left 2D = 14. 417 + (0.805 x Right 2D)	2.29	8.80	0.86	0.73	<0.001
Left 2D = 15.211 + (0.763 x Left 4D)	2.77	7.12	0.68	0.46	<0.001
Left 4D = 16.003 + (0.803 x Left 2D)	2.84	7.32	0.78	0.61	<0.001
Left 4D = 12.130 + (0.873 x Right 4D)	2.34	6.97	0.86	0.74	<0.001

Figure 5

Table 5: Regression of height on 2D and 4D in males and females

Sex	n	Equations	SEE	t	r	r^2	P
Males	650	Ht= 113.512 + (0.108 x Right 2D) + (0.141 x Right 4D) + (0.132 x Left 2D) + (0.398 x Left 4D)	5.99	29.82	0.53	0.28	<0.001
		Wt= 13.42 + (0.106 x Right 2D) + (0.180 x Right 4D) + (0.176 x Left 2D) + (0.224 x Left 4D)	8.72	1.98	0.35	0.12	0.02
Females	431	Ht= 112.731 – (0.077 x Right 2D) + (0.135 x Right 4D) + (0.595x Left 2D) + (0.033 x Left 4D)	5.47	24.99	0.48	0.23	<0.001
		Wt= 14.93 + (0.034 x Right 2D) + (0.156 x Right 4D) + (0.402 x Left 2D) + (0.006 x Left 4D)	8.98	2.02	0.27	0.07	0.04

Ht = Height Wt= Weight

DISCUSSION

This study was designed to see if there is relationship between 2D, 4D lengths with height and weight. This was to investigate if these parameters could be used to predict height and weight, as different body parts have been used for

the prediction of height and weight for the possible identification of individuals in forensic investigation [2378].

The present study has demonstrated a significant ability to estimate 2D from 4D and 4D from 2D in both males and females and from both right and left hands. Predictive equations generated for heights from right and left 2D and 4D showed that the predictive values is higher in the males than in the females. This is in agreement with findings of El-Megaly et al [8] reporting the same phenomena in establishing stature from tibial length and malleolar breadth in an Egyptian sample, and Krishan and Sharma [3] reporting on estimation of height from hand and foot length in a north Indian population. This implies that the ability to accurately predict height from 2D and 4D is greater in the males than the females due to the lower values of standard error of estimates [3].

The result of the present study has shown that the lengths of 2D and 4D can successfully be used to estimate height and to a lower degree weight by forensic scientists during the process of identifying remains. But it should also be realised that there are population variation in anthropometric dimensions, which are influenced by genetics and environmental factors [81112]. So the regression equations generated from this study may only be very useful in estimating height and weight in Nigerians.

The results of the linear regression of right and left 2D and 4D in males and females clearly shows that the length 2D and 4D in the right hand could be used to predict 2D and 4D lengths in the left hand with high degree of significance. This is useful in forensic investigation where dismembered bodies are required to be fully identified.

Multivariate analysis of the right and 2D and 4D length on height and weight, it was observed that the 2D and 4D gave higher correlations and significance than weight in both males females. The predictive ability is higher in the males than the females.

In conclusion, it was observed from this study that second and fourth digits lengths could be used as a utility in estimating height and weight, and digits in right hand could estimating accurately the lengths of digits in the left hand and vice versa.

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