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RESEARCH ARTICLE

Estimations of Body Composition Using Adjacent Digit Fingerprint Ridge Density Difference in Kano, Nigeria

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ABSTRACT

Background: The evolution of fingertip ridges over the years is to allow humans to grasp and grip objects as well as in sex identifications. Fingerprint ridges form through a combination of genetic and environmental factors as a results, no two individuals have same pattern.

Aim: The study aimed at determining sexual dimorphism and relationship between body composition and adjacent digit fingerprint ridge density difference (adj. DFRDD).

Materials and Methods: The study design was prospective cross-sectional type which involves a total number of 300 students (150 males and 150 females). Bioelectric impedance machine was used for measurements of body composition parameters. A direct sensing method was used for fingerprint capturing. Ridge density was determined from the count of ridges found diagonally within a 25mm^2 in ulnar and radial areas. The Adj. DFRDD was determined by subtracting the ridge density from adjacent digits.

Results: The results showed a significant sexual dimorphism in ridge density with females having significantly higher median values. A significant difference was also observed between Adj. DFRDD of right 2nd and 4th digits (Rd24), right 3rd and 4th digits (Rd34), left 2nd and 3rd digits Ld23) and left 2nd and 4th digit (Ld24), with males having higher adj. DFRDD. A significant correlation was observed while % body fat, muscle mass and resting metabolism correlated significantly with adj. DFRDD of Rd12, Rd13, Rd15, Rd24, Ld12, Ld13, Ld15 and Ld24 digits. The adj. DFRDD of Rd14 and Ld45 correlated only with % body fat and muscle mass. The muscle mass and resting metabolism in other hand correlated only with the adj. DFRDD of Rd45 and Ld23. However, the resting metabolism additionally correlated with the adj. DFRDD of Rd34, Ld14 and Ld35.

Conclusion : The best predictors of % body fat and muscle mass was found to be Rd12. Whereas the Ld12 was found to be the best predictor of resting metabolism. In conclusion, a significant sexual dimorphism and relationship was established between the Adj. DFRDD with body composition, hence, the adj. DFRDD may be used a tool for estimation of some body composition parameters.

Keywords: Body composition, Fingerprints ridge density, sexual dimorphism

INTRODUCTION

Human fingers are described to display friction ridge skin that consists of a series of ridges and furrows, generally considered as fingerprints. It is the representation of the epidermis of a finger and consists of a pattern of interleaved ridges and valleys (Babler, 1991). Fingertip ridges evolved over the years to allow humans to grasp and grip objects (Andre´ *et al.,* 2010; Yum *et al.,* 2020) and for sensing of surface textures (Loesch and Martin, 1984; Medland *et al.,* 2007; Scheibert *et al.,* 2009). Fingerprint ridge density is crucial for sex identification in both anthropological and forensic science (Kaur *et al.,* 2020). Like everything in the

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human body, fingerprint ridges form through a combination of genetic and environmental factors (Pechenkina *et al.,* 2000; Kahn *et al.,* 2001). No two individuals including identical twins have similar fingerprint (Maltoni *et al.,* 2006).

Body composition, can be identified by using several measurements such as body mass index (BMI), waist to hip ratio (WHR), skinfold test, and bioelectrical impedance analysis (BIA) however, these measurements have limited usage. Many laboratory-based methods to estimate body composition also exist, but only a few of these methods provide rapid, easy, and effective estimation of body composition. Several of the broadly defined components of body composition, e.g., muscular tissue, are a conglomerate of individual units, each possibly differing in their genetic basis (John *et al.,* 1999).

Several studies have examined correlations between fingerprint measurements to some health-related conditions such as obesity (Valiollah, 2011). Despite the well-established correlations between dermatoglyphics and obesity, the correlations between fingerprints features (Oladipo *et al.,* 2010). It was suggested that the difference between males and females in a given ridge characteristic such as thumbprint features may be linked to sexual dimorphism in body proportions in which on average males have larger body frame than females (Kapoor and Badiye, 2015; Krishan *et al.,* 2010). Although, ethical difference exists in the dR45 and WTR values, these relations were found for both the White and Black recruits in Atlanta sample (Henry *et al.,* 2001). These ridges form during weeks 10–16 of fetal development (Babler, 1991; Kücken and Newell, 2005), are not subjected to environmental alterations after birth. Consequently, dermatoglyphic asymmetry can be used to measure developmental instability during a precise period of fetal development (Arrieta *et al.,*1993; Rose *et al.,* 1987).

Despite the existence of influences on the testosterone on both fingerprint ridges and body composition, there is scarcity of data on the relationship between adjacent fingerprint asymmetry and body composition parameters. The relationship between adjacent fingerprint asymmetry and adiposity indices receives less attention in the literature among our target population. There is need of reference data or baseline data the adjacent digit fingerprint ridge density differences (adj. DFRDD), body composition among the study population. The use of adjacent fingerprint asymmetry in estimation of body composition would help in providing information useful in evaluating the health status of individual. This study would also provide information useful defining and determining the developmental instability that might have occurred in an individual. The adjacent fingerprints asymmetry may also serve as screening tool for individuals with abnormal body composition. This study was designed to investigate the relationship between body composition parameters with ridge counts asymmetry of adjacent and lateral digits of students of Faculty of Basic Medical Sciences of Bayero University, Kano and Maitama Sule University, Kano.

MATERIALS AND METHODS

Study Area

The study was conducted at Bayero University, Kano, College of Health Sciences which comprises of four faculties as follows: Faculty of Allied Health Sciences, Faculty of Basic Medical Sciences, Faculty of Clinical Sciences, and Faculty of Dentistry, and Maitama Sule University (formally known as North West University), Faculty of Basic Medical Sciences, consist of three departments; Anatomy, Biochemistry and Physiology.

Study Population

A total number of 300 students comprising of 150 males and 150 females participated in the study with mean age of 21.94± 2.31 (range of 18-30). The inclusion criteria involved any students that are registered to the two Universities, who are within the College of Health Sciences, Faculty of Basic Medical Sciences and without any physical deformity especially in the tip of the fingers and belong to Hausa population.

Ethical approval

Ethical approval was obtained from the department of Anatomy, Faculty of Basic Medical Sciences, Bayero University, Kano, and informed consent was also obtained from the participants before the commencement of the study.

Methodology

The study design is cross sectional type which involves the collection of the Bio-data and some anthropometric parameters.

Collection of bio-data

The Bio-data was collected using questioner. The information collected include sex, age, ethnicity of the participant.

Height and body composition Anthropometry

The body height was measured from the vertex of the head of the subject to the sole of his foot, using stadiometer (RZ-160) following standard protocol to the nearest 0.5 cm. Bioelectric impedance machine (BIM) (Omron, HBF-514, China) was used for measurements of body composition parameters. The subject was asked step on BIM flatform bare-footed; with the feet in contact with the flatform electrode, and stand with his weight evenly distributed. While standing with his knees and back straight, the participant was asked to raised his/her arms horizontally and extend elbow straight (both at 90^0 to his body) and hold a handle of electrodes of BIM. Various personal information such as chronological age, gender and height (measured using stadiometer) were imputed into BIM, Then the participant was asked to steps off the BIM platform. The eight body composition parameters (Weight, BMI, % body fat, % muscle mass, resting metabolism, body age, relative visceral fat level) were calculated automatically. The body composition parameters were later recorded into the proforma.

Fingerprint anthropometry

Fingerprint was captured using direct sensing method adopted from the previous study (Adamu *et al.,* 2016 and Adamu *et al.,* 2018). Ridge density was determined as the number of ridges in a given space. The density was determined from the count of ridges found diagonally within a $25mm^2$ area on the fingertip surface located on the radial and ulna side of the distal regions of each finger as proposed in the previous studies (Acree, 1999; Adamu *et al.,* 2016 and Adamu *et al.,* 2018).

To determine adj. DFRDD, a number was assigned to each digit (thumb through little digit) as 1(thumb), 2 (index), 3 (middle), 4 (ring), 5 (little). The sides were defined as R (right) and L (left) and letter (d) stand for the difference in ridge count between digits. adj. DFRDD was defined as the difference between one digit and next forward digit(s) as described by Kahn *et al.,* (2001), example Rd12, Rd13… Rd45 & Ld12, Ld13 … Ld45.

Measurement error

The values for the Cronbach's Alpha (reliability coefficient) ranged from 0 to 1, 0.6 to < 0.8 “substantial reliability”, and 1 “almost perfect reliability” (Shrout and Fleiss, 1979). The Cronbach's alpha of the ridge density of the ten digits range from 0.99-1.00, except for radial left little and right thumb 0.94 and 0.74 respectively. The measurement analyses were carried out only on 30 selected participants.

Statistical Analyses

The data were expressed in mean ± SD, median and quartiles. Mann Whitney was used to determine the sexual dimorphism in the study parameters. Pearson correlation analysis was used to determine the correlation between adj. DFRDD to body composition. Step-wise multiple regression analyses were used to generate a model for estimation of body composition parameters from adj. DFRDD. SPSS version 20 (IBM Corporation, for Windows), was employed for analysis of data. $P < 0.05$ was set as the level of significant.

RESULTS

Table 1 shows descriptive statistics and sexual dimorphism of height, body composition and fingerprint ridge count of male and female participants. It was observed that males had significantly higher mean and median values compared to females. For both height and weight males had significantly higher mean and median values. A significant difference between males and females was observed in all the body composition parameters except in the BMI where no significant differences exist between the sexes. The significantly higher mean and median values were observed only in the muscle mass and resting metabolism in male participant compared to the female participants. With respect to fingerprint ridge counts, sexual dimorphism existed in index and little digit of both right and left digits.

Table 2 shows descriptive statistics and sexual dimorphism in adj. DFRDD. A significant difference was found in Rd12, Rd13, Rd15, Rd45, Ld12, Ld13, Ld15, Ld35 and Ld45. Which showed that females had significantly higher mean and median values compared to male counterpart. A significant difference was also observed in Rd24, Rd34, Ld23 and Ld24, which shows that males had higher mean and median values. Whereas all the remaining variables had no any significant differences between the sexes.

Table 3 shows Pearson’s correlation for relationship between body composition with adj. DFRDD. It was found that BMI, metabolic age and visceral fat does not correlate with any variable below. Rd12, Rd13, Rd14, Rd15, Rd24, Ld12, Ld13, Ld15, Ld24 and Ld45 were significantly correlated with Body fat. A significant correlation of Rd12, Rd13, Rd14, Rd15, Rd24, Rd45, Ld12, Ld13, Ld15, Ld23, Ld24

Table 1: Descriptive statistics and sexual dimorphism of age, height, body composition and fingerprint ridge count

	Male			Female			
Variables	Mean ± SD	Min-Max	Median (25,75)	Mean ± SD	Min-Max	Median (25th, 75th)	Z value
Height (cm)	169.67± 6.69	157-196	169.75(165, 73.5)	158.62±5.66	143.50-172.00	158.25(155,162.63)	-12.07**
Weight (Kg)	58.45±8.55	44.30 -104.60	57.60(52.75,61.88)	52.11± 10.74	37.60-99.60	48.95(45.4,55.1)	-7.56**
BMI (Kg/m^2)	20.30± 2.18	17.20 - 30.90	19.90(18.68,21.3)	20.62± 3.88	14.40-36.60	19.90(18.2,21.95)	-0.82
% Body Fat	13.15±5.79	5 - 38.20	11.95(8.98,16.2)	28.66± 7.83	10.10-53.30	27.35(23.2,33.13)	-13.52**
% Muscle Mass	43.84±3.66	28.50 -49.90	44.30(42.08,46.4)	27.34±3.15	20.10- 43.00	27(25.2,28.7)	-14.78**
Resting Metabolism	1487.87± 119.62	1153 -2058	1474.5(1409.75,1555.25)	1223.80± 120.86	1034-1783	1186(1146.5,1263.5)	-13.13**
Body age (years)	20.20± 6.57	18 -69	18.00(18,18)	22.85±8.97	18.00-61.00	18(18,23)	-3.46**
Relative visceral fat level	2.75± 1.95	1 -12	2(1,4)	3.03±1.68	1.00-14.00	3(2,4)	-2.45*
Right thumb ridge count	9.84±1.16	7 -13	10(9,10)	9.63±0.94	8.00-13.00	10(9,10)	-1.29
Right index ridge count	10.52±1.32	8 -14	10.5(9.5,11.5)	10.93±1.13	8.00-14.00	11(10.5,11.63)	-3.07*
Right middle ridge count	10.94±1.29	7 -14.5	11(10,12)	11.19±1.05	7.50-15.00	11(10.5,12)	-1.86
Right ring ridge count	11.15±1.16	8 -14.5	11(10.5,12)	11.17±0.98	9.00-15.00	11.5(10.5,12)	-0.05
Right little ridge count	11.19±1.07	9 -14	11(10.5,12)	11.55±1.15	8.50-17.50	11.5(10.88,12.5)	-2.76*
Left thumb ridge count	9.89± 1.06	7.5 – 13	10(9.5,10.5)	9.78±0.86	7.50-13.50	10(9.5,10.5)	-0.78
Left index ridge count	10.50± 1.27	7.5 -14	10.5(9.5,11.5)	11.03±1.23	8.50-15.50	11(10,12)	-3.54**
Left middle ridge count	11.10±1.30	7 – 15	11(10,12)	11.28±1.10	8.50-16.50	11.5(10.5,12)	-1.50
Left ring ridge count	11.18±1.12	8.5 -14.5	11(10.5,12)	11.24±1.10	8.50-18.00	11.5(10.5,12)	-0.34
Left little ridge count	11.24± 1.23	9 -15	11.(10.5,12)	11.68±1.22	8.50-18.00	11.5(11,12.5)	-3.35**

*P < 0.05, **P <0.001, SD; standard deviation, max; maximum, min; minimum, 25th& 75th; percentiles.

Table 2: Descriptive statistics and sexual dimorphism in adj. DFRDD

	Male			Female			
Variables	Mean ± SD	Min-Max	Median (25,75)	Mean ± SD	Min-Max	Median (25th, 75th)	Z value
Rd12	-0.70± 1.21	-4 -3	-0.5(-1.5,0)	-1.31±0.84	-3 - 1.5	-1.50(-2, -1)	-4.77**
Rd13	-1.12± 1.1	-3.5 – 3	-1(-2, -0.5)	-1.56±0.75	-35 - 0.5	-1.50(-2, -1)	-3.50**
Rd14	-1.33± 1.08	-3.5 - 2.5	-1.5(-2, -0.5)	-1.54±0.79	-3.5 - 0.5	-1.5(-2, -1)	-1.52
Rd15	-1.37±0.99	-3.5 - 1.5	-1.5(-2, -0.5)	-1.93±0.80	-4.5 - 0.0	-2(-2.5, -1.5)	-4.72**
Rd23	-0.42±1.09	-3 - 2.00	-0.5(-1,0.5)	-0.26±0.92	-3 – 2	0(-1,0.5)	-1.41
Rd24	-0.64±1.03	-3 - 2.00	-0.5(-1.5,0)	-0.24±1.00	-3 - 2.5	0(-1,0.5)	-3.34**
Rd25	-0.67±1.01	-3 – 2	-0.5(-1.5,0)	-0.62±0.95	-4 - 1.5	-0.5(-1.5,0)	-0.86
Rd34	-0.22± 0.92	-2.5 -2	0(-1,0.5)	0.02±0.92	-2.5 – 2	0(-0.5,0.5)	-2.27*
Rd35	-0.25±1	-2.5 - 2.5	-0.5(-1,0.5)	-0.36±0.81	-2.5 - 1.5	-0.5(-1,0)	-0.58
Rd45	-0.04±0.94	-2 -2.50	0(-1,0.5)	-0.38±0.95	-3 – 2	-0.5(-1,0.5)	-2.98*
Ld12	-0.62±1.1	-3.5 – 2	-0.5(-1.5,0)	-1.25±0.96	-3.5 - 1.5	-1.00(-2, -0.5)	-4.90**
Ld13	-1.21±1.11	-4.5 - 1.5	-1(-2, -05)	-1.50±0.79	-3.5 – 1	-1.5(-2, -1)	-2.52*
Ld14	-1.30±1.06	-3.5 - 1.5	-1.5(-2, -0.5)	-1.46±0.79	-4.5 – 1	-1.5(-2, -1)	-1.27
Ld15	-1.35± 1.14	-4 – 2	-1.5(-2,0.88)	-1.90±0.87	-4.5 - 0.5	-2(-2.5, -1.5)	-4.44**
Ld23	-0.60± 1.22	-4.5 - 2.5	-0.5(-1.5,05)	-0.25±0.90	-2 - 1.5	-0.5(-1,0.5)	-2.50*
Ld24	-0.68±1.13	-3.5 – 2	-0.5(-1.5,0)	-0.21±0.96	-3.5 - 2.5	0-1,0.5)	-3.49**
Ld25	-0.74± 1.09	-4 – 2	-0.5(-1.5,0)	-0.65±0.97	-2.5 – 2	-0.75(-1.5,0)	-0.06
Ld34	-0.08± 1.1	-3 - 3.5	0(-1,0.5)	0.04±0.83	-3.5 – 2	0(-0.5,0.5)	-1.87
Ld35	-0.14± 1.12	-3 - 3.5	0(-1,0.5)	-0.40±0.79	-2.5 -2.5	-0.5(-1,0)	-2.33*
Ld45	-0.06± 1	-2 - 2.5	0(-1,0.5)	-0.44±0.89	-3 – 3	-0.5(-1,0)	-3.08*

* P < 0.05, **P <0.001, SD; standard deviation, max; maximum, min; minimum, 25th& 75th; percentiles. R; right, L; left, d; difference, 1; thumb, 2; index, 3; middle, 4; ring, 5; little

Table 3: Pearson's correlation for relationship between body composition with adj. DFRDD

Variables	BMI (Kg/m^2)	% Body Fat	% Muscle Mass	Resting Metabolism	Metabolic Age (years)	Relative visceral fat level
Rd12	-0.022	-0.249**	0.299**	0.241**	-0.070	-0.065
Rd13	0.017	-0.172**	0.226**	0.189**	-0.018	0.027
Rd14	-0.073	-0.133*	0.119*	0.0036	-0.081	-0.040
Rd15	0.016	-0.221**	0.282**	0.195**	-0.003	-0.040
Rd23	0.040	0.102	-0.105	-0.078	0.058	0.096
Rd24	-0.044	0.138*	-0.202**	-0.249**	-0.001	0.031
Rd25	0.040	0.063	-0.060	-0.080	0.075	0.034
Rd34	-0.093	0.042	-0.112	-0.193**	-0.064	-0.070
Rd35	-0.001	-0.046	0.052	0.001	0.016	-0.070
Rd45	0.089	-0.085	0.158**	0.188**	0.078	0.001
Ld12	0.054	-0.198**	0.266**	0.285**	0.000	0.034
Ld13	-0.006	-0.117*	0.145*	0.098	-0.046	0.023
Ld14	0.032	-0.027	0.061	0.124*	0.008	0.043
Ld15	-0.003	-0.189**	0.235**	0.198**	-0.043	0.043
Ld23	-0.059	0.092	-0.134*	-0.197**	-0.041	-0.013
Ld24	-0.026	0.176**	-0.215**	-0.179**	0.006	0.004
Ld25	-0.060	0.016	-0.040	-0.098	-0.044	0.008
Ld34	0.037	0.091	-0.087	0.021	0.053	0.018
Ld35	0.002	-0.086	0.107	0.115*	-0.001	0.023
Ld45	-0.035	-0.178**	0.195**	0.094362564	-0.054	0.004

*P <0.05, **P< 0.01, R; right, L; left, d; difference, 1; thumb, 2; index, 3; middle, 4; ring, 5; little

Table 4: Step-wise multiple linear regressions for prediction of body composition from fingerprints ridge counts and adjacent asymmetry

Variables	Steps	Equation (Y= mx + c)	R	R^2	SEE	F	P value
%Body fat	1	BF= (-2.382) Rd12+18.518	0.249	0.062	10.07	19.64	<0.001
	2	BF= (-2.186) Rd12+(-1.562) Ld45+18.327	0.287	0.083	9.97	13.38	<0.001
%Muscle mass	1	MM= (2.465) Rd12+38.060	0.299	0.089	8.55	29.18	<0.001
	2	MM= (2.106) Rd12+(1.450) Ld15+40.060	0.341	0.116	8.43	19.51	<0.001
	3	MM= (1.771) Rd12+(1.451) Ld15+(-1.166) Ld24+39.207	0.366	0.134	8.36	15.28	<0.001
	4	MM= (2.525) Rd12+(1.103) Ld15+(1.275) Ld24+(1.315) Rd25+40.198	0.382	0.146	8.32	12.59	<0.001
Resting metabolism	1	RM= (47.215) Ld12+1399.904	0.285	0.081	171.47	26.44	<0.001
	2	RM= (38.080) Ld12+(-30.440) Rd24+1378.014	0.331	0.110	169.11	18.27	<0.001
	3	RM= (33.080) Ld12+(-30.842) Rd24+(25.540) Rd13+1407.467	0.357	0.128	167.66	14.44	<0.001

SEE; standard error of estimate, R; right, L; left, d; difference, 1; thumb, 2; index, 3; middle, 4; ring, 5; little and Ld45 with muscle mass was observed. It was also observed that Rd12, Rd13, Rd15, Rd24, Rd34, Rd45, Ld12, Ld13, Ld14, Ld15, Ld23, Ld24 and Ld35 significantly correlated with resting metabolism.

Table 4 shows step-wise multiple linear regressions for prediction of body composition from fingerprints ridge counts and bilateral asymmetry. Rd12 were found to be very significant in body fat and muscle mass formula for prediction of body composition from fingerprints ridge counts and adjacent asymmetry.
Ld12 was also a significant variable in the formula for predicting the of body composition from fingerprints ridge counts and adjacent asymmetry.

DISCUSSION

There is a strong sexual dimorphism in all the body composition considered in this study except in BMI, with males having significantly higher mean and median values. The primary androgenic hormone, testosterone (T), is responsible for the development of secondary sexual characters and promotion of skeletal growth (Folstad, and Karter ,1992). Two studies showed that the males have higher ridge count than the females (Hall and Kimura, 1994; Karine *et al.,* 2002). These contrasting growth patterns diverge further during adolescence, with girls gaining considerable amounts of fat but relatively little lean, and boys showing the opposite strategy (de Bruin *et al.,*1982; Wells *et al.,* 2000). These changes are primarily hormonally driven (Haschke, 1989; Maynard *et al.,* 2001); however, reduced energy expenditure in girls during puberty may also be important.

The end result by early adulthood is that while the sexes have relatively similar weight for height (BMI), the ratio of lean to fat is much greater in males than females (Goran*et al.,* 1998). It was shown that both males and females have higher rightward directional asymmetry in the ridge count (Sanders and Kadam, 2001, Karine*et al.,* 2002, Sukanta*et al.,* 2003, and Jeffrey *et al.,* 2006), with the asymmetry being higher in males than females (Sanders and Kadam, 2001), and higher incidence of leftward asymmetry in females (Karine*et al.,*2002). Female's fingerprints are significantly of lower quality than male fingerprints (Austin and Christopher,2002) sexual dimorphism existed in index and little digit of both right and left digits. Well relationship between dermatoglyphics and obesity, the correlations between fingerprints features like ridge counts (Oladipo *et al.,* 2010).

In this study a significant difference was also observed in adjacent and lateral ridge count asymmetry of right 2nd and 4th digit (Rd24), right 3rd and 4th digit (Rd34), left 2nd and 3rd digit (Ld23) and left 2nd and 4th digit (Ld24), with males having higher mean asymmetry. A significant relationship was observed between % body fat, muscle mass and resting metabolism that correlated with ridge count asymmetry of adjacent (Rd12, Rd13, Rd24, Ld12, Ld13 Ld24) and lateral (Rd15 and Ld15) digits. In previous researched adjacent ridge count asymmetry of Rd14 and Ld45 correlated only with % body fat and muscle mass. The muscle mass and resting metabolism in other hand correlated only with adjacent ridge count asymmetry of Rd45 and Ld23.

It also observed a relationship between second and fourth ridges count ratio and anthropometric body composition which indicate significant different between men and women (Fink *et al.,* 2003). As far as structural features are concerned, men occupied the higher mesomorphy, ectomorphy and endomorphy component, thus structural features towards dominant mesomorphy can be written as male type features (Camhi *et al.,*2011). However, no relationship was found in heterosexual males or females (Kimura & Carson, 1995). A study of homosexual men found there was an association between leftward asymmetry and an increase in non-right-handedness (Hall &Kimura, 1994). Homosexual males have been found to have an increased incidence of non-right-handedness (Lindesay, 1987; McCormick *et al.,* 1990).

Previous research provided another way of predicting of body composition from fingerprints ridge counts and bilateral asymmetry. Rd12 were found very significant in body fat and muscle mass. These ridges form during weeks 10–16 of fetal development (Babler ,1991; Kücken and Newell, 2005), and are not subject to environmental alterations after birth. Consequently, the genes for limb development and the correlation of hand proportions with dermatoglyph types demonstrate the key role of embryonic limb growth processes in defining the intricate surface patterning of the human fingerprint. (Li *et al.,* 2022), and dermatoglyphic asymmetry can be used to measure developmental instability during a precise period of fetal development (Rose *et al.,* 1987 and Arrieta *et al.,* 1993).

CONCLUSION

Based on the findings of this study, the adjacent and lateral ridge asymmetry exhibited significant correlation with body composition parameters (height, weight, % body fat, %

muscle mass and resting metabolism), with Rd12 being the best predictor of body composition. However BMI cannot be predicted from fingerprint ridges count of most of the digits.

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Conflict of Interest
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Authors Contributions
Conception and design of study: LHA, MKR, TLS, AYA, MGT
Acquisition of data: LHA, UAM, SBN, AYA
Analysis and interpretation: LHA, UAM, SBN, AYA
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