

ORIGINAL ARTICLE**Correlation of fingerprint ridge density and body mass index among Nigerians**

Haruna Shuaibu Kumurya^{1*}, Halima Musa Uba², Hassan Ibrahim², Ahmad Isa Muhammad², Ibrahim Muhammad Dauda¹, Maryam Issa Shariff², Lawal Jibia Abubakar⁵, Isyaku Ibrahim⁶, Kabiru Bilkisu Umar³, Musa Abubakar², Lawan Hassan Adamu³, Abdullahi Yusuf Asuku², Magaji Garba Taura⁴

¹Human Anatomy Unit, Faculty of Basic Health Sciences, Al-istiqama University, Sumaila, Kano, Nigeria, ²Department of Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences, Bayero University Kano, Kano, Nigeria, ³Department of Human Anatomy, Faculty of Basic Medical Sciences, College of Medicine and Allied Medical Sciences, Federal University Duste, Duste, Nigeria, ⁴College of Medicine, University of Bisha, Bisha, Saudi Arabia ⁵Department of Human Anatomy, Faculty of Basic Medical Sciences, College of Medical Sciences, Ahmadu Bello University Zaria, Kaduna, Nigeria, ⁶Department of Human Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences, Yusuf Maitama Sule University Kano, Nigeria

Abstract

Background: The texture formed by interleaved ridges and valleys on the top of human fingertip is referred to as fingerprint, which is well known to be relevant in diagnosis of some genetic disorders. Body Mass Index (BMI) is a widely utilised metric for identifying and assessing obesity within populations. **Aim and Objectives:** The study aimed to determine the correlation of fingerprint ridge density with BMI among Hausa population of selected tertiary institutions in Kano metropolis, Nigeria. **Material and Methods:** A total number of 401 students (216 males and 185 females) took part in the study. The BMI was calculated as weight (kg) divided by square of height (m²). Using live scanner the fingerprints of the ten digits were captured. For each digit, 25mm² was defined in ulnar and radial side for determination of fingerprint ridge density. Pearson correlation test was used to correlate between the ridge density and BMI. **Results:** A significant correlation between the ulnar ridge densities with BMI of the little finger on both hands was observed. Based on sex, a significant correlation of ulnar left little and radial left little fingers with BMI was observed only in female participants with no such correlation in male counterparts. Among females, there was a significant correlation between fingerprint ridge density and BMI. The finding of this study revealed that fingerprint ridge density may be used as a marker of an individual's BMI.

Keywords: Adiposity, Body mass index, Fingerprint ridges, Hausa population

Introduction

A fingerprint is the representation of the epidermis of a finger; it consists of a pattern of interleaved ridges and valleys [1]. The ridges evolved over the years to allow humans to grasp an object and is formed through a combination of environmental and genetic factors [2-4]. The ridge patterns on the skin are permanent and unique and stay so, from

cradle to grave, unless the dermis is damaged [5]. It has been extensively employed in bioanthropology, genetics, and evolutionary research to investigate the nature and origins of human variation and to define populations [6]. The concept of the pattern of dermatoglyphics has been of great importance in personal identification and sex determination as reported by

Moorthy and Rajathi that, the mean palmprint ridge density was significantly greater in females than males [7]. Years of research have shown that the papillary ridges on the fingers, palms, soles, and toes remain consistent throughout a person's life, unless significantly altered by a deep injury that disrupts their natural pattern [8]. Another study also indicated definite correlation of fingerprint pattern of thumb with academic performance of medical students which can be used as predictor of low performers so as to initiate necessary measures [9]. The uniqueness of fingerprint has been applied to many fields including criminal verification, financial institutions, access control, etc. [10]. Besides its forensic application, fingerprints have been utilized as a diagnostic tool for different health conditions, such as diabetes, cancer, hypertension, and heart disease [11-14].

Body mass index (BMI), calculated as the ratio of weight to height (kg/m^2), serves as a straight forward way for assessing body size and estimating obesity across diverse populations worldwide [14, 15]. This is due its accuracy, simplicity and association with diseases [16]. The advantage of BMI as an index of obesity is the availability of extensive national reference data worldwide, its established relationships with levels of body fatness, morbidity and mortality [16, 17]. BMI was also reported to significantly predict individuals' future risk of diseases and associated morbidities [16].

Previous studies examined the relationship between fingerprint pattern with some health-related variables including BMI [17], obesity [18], raised blood pressure [19], chromosomal disorders [20], schizophrenia [21] and male pattern baldness [22] among others, which reveals the potential of

fingerprint for possible assessment of the health status of individuals. Nevertheless, such studies only considered fingerprint pattern, ridge counts, ridge density of thumb, with no attempt to discover the relationship of other fingerprint features like ridge density and other digits with BMI and BP especially Hausas. This study provided an insight on the role of fingerprint ridge density in the estimation of BMI. It may also be helpful in providing information useful in evaluating the possible risk of diseases associated with abnormal BMI using fingerprint ridge density. The fingerprint ridge density may also serve as an additional screening tool for evaluation of individuals at risk of developing obesity.

Material and Methods

The study was conducted at College of Health Sciences, Bayero University Kano (CHS-BUK) which comprises of four Faculties: Allied Health Sciences, Basic Medical Sciences, Clinical Sciences, and Dentistry. Additionally, Faculty of Basic Medical Sciences, Yusuf Maitama Sule University, Kano (YUMSUK) was also involved. The ridge density was determined from the count of ridges found diagonally within a 25mm^2 area on the fingertip surface located on the radial and ulnar side of the distal regions of each finger, the height and weight were measured using standard protocol.

The following formula was used to determine the sample size: [23]

$$n = \frac{(z^2 pq)}{d^2}$$

Where; n= minimum sample size' z= standard normal deviation with confidence interval of 95% (± 1.96) p= proportion in the target population (50%) 0.5' q= 1-p, 1-0.5= 0.5' d = sampling error which is 5% (0.05)

$$n = \frac{(1.96)^2 \times 0.5 \times 0.5}{(0.05)^2} = 384$$

(minimum number of subjects needed for the study)

Using simple random sampling, a total of 401 students (216 males and 185 females) of the CHS-BUK and FBMS-YUMSUK with mean age of 21.75 ± 2.58 (18-30 years), were recruited in the study. Only registered students of CHS-BUK, and Faculty of Basic Medical Sciences, YUMSUK who were healthy with no physical deformities especially at vertebral column and tip of their digits were included. Participants that belonged to Hausa ethnic origin were also included.

Informed consent was obtained from the participants prior to the commencement of the study. The study was conducted also in accordance with Helsinki declaration, 1999. This study was part of the project approved by Anatomy Departmental Board (ADB-2018), Faculty of Basic Medical Sciences, Bayero University Kano. Cross sectional type of the study that involved the collection of the bio-data using a proforma and fingerprint parameters using customized in-house software (Print analyzer) developed using Microsoft visual basic version 6 programming language was employed. A proforma was used to collect the age, gender, ethnicity, height, weight and BMI. The height of the subjects was measured as a vertical distance from the standing surface to the vertex of the head using a stadiometer (RGZ, 160 Body with a minimum measurement of 1 cm), while their weights were measured using a digital weighing scale (of resolution 0.1 mg). BMI was calculated as persons weight in kilograms divided by the square of the person's height in meters (kg/m^2). Digital live scan (digital persona, China) was used to capture the

fingerprint as proposed in the previous study [18]. Ridge density was defined 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 ulnar side of the distal regions of each finger as adopted in the previous studies [17, 18]. Data were presented as mean \pm Standard Deviation (SD). To assess the correlation between fingerprint ridge density and BMI, Pearson's correlation coefficient was employed. The data were analyzed using the Statistical Package for Social Sciences (SPSS) software version 20. The value of $p < 0.05$ was considered as level of significance.

Results

The minimum and maximum values of the BMI were 13.22 and 40.58 respectively, with mean value of 20.11 ± 3.52 . Highest mean value for ulnar ridge density (10.22 ± 1.69) was observed in ulnar left ring, while lowest mean value (9.21 ± 1.39) was seen in ulnar right thumb (Table 1). The minimum value (4.00) was observed in radial left little while the maximum value was observed in the radial right middle and radial left little (16.00). Radial left little had the highest mean value (10.48 ± 1.56) whereas radial right thumb had the lowest mean value (9.48 ± 1.38) (Table 2). The study reported a significant correlation between BMI and fingerprint ridge density only in ulnar left little and ulnar right little. The correlation of the BMI with ulnar left little ridge density was more significant than the correlation with ulnar right little ridge density. For radial fingerprint ridge density, it was found that there was insignificant correlation between the entire radial fingerprints ridge density with BMI (Table 3). Ulnar fingerprint ridge density had no correlation with BMI in males but

significant correlation (negative) between ulnar left little and BMI existed in females. While no statistical correlation was observed between radial

fingerprints with BMI in males, females displayed a significant correlation (negative) between left little and BMI (Table 4).

Table 1: Descriptive statistics of body mass index and ulnar fingerprint ridge density

Variables	Minimum	Maximum	Mean ± SD
Body mass index (kg/m ²)	13.22	40.58	20.11 ± 3.52
Ulna right thumb RD	6.00	14.00	9.21 ± 1.39
Ulna left thumb RD	6.00	14.00	9.37 ± 1.45
Ulna right index RD	6.00	14.00	9.65 ± 1.41
Ulna left index RD	7.00	14.00	9.86 ± 1.38
Ulna right middle RD	6.00	17.00	9.93 ± 1.62
Ulna left middle RD	6.00	15.00	9.99 ± 1.61
Ulna right ring RD	6.00	15.00	10.12 ± 1.58
Ulna left ring RD	6.00	17.00	10.22 ± 1.69
Ulna right little RD	6.00	15.00	10.04 ± 1.53
Ulna left little RD	6.00	16.00	10.20 ± 1.49

**Significantly different from control at P<0.05*

Table 2: Descriptive statistics of radial fingerprint ridge density

Variables	Minimum	Maximum	Mean ± SD
Radial right thumb RD	5.00	13.00	9.48 ± 1.38
Radial left thumb RD	5.00	15.00	9.58 ± 1.47
Radial right index RD	6.00	15.00	9.77 ± 1.38
Radial left index RD	6.00	15.00	9.82 ± 1.35
Radial right middle RD	6.00	16.00	10.08 ± 1.40
Radial left middle RD	6.00	14.00	9.99 ± 1.49
Radial right ring RD	6.00	15.00	10.25 ± 1.63
Radial left ring RD	6.00	15.00	10.27 ± 1.58
Radial right little RD	6.00	15.00	10.41 ± 1.47
Radial left little RD	4.00	16.00	10.48 ± 1.56

SD: standard deviation, RD: ridge density

Table 3: Relationship between ulna and radial fingerprint ridge density with body mass index

Body mass index (kg/m ²)			
Variables	Correlation coefficient (r)	Variables	Correlation coefficient (r)
Ulnar right thumb RD	-0.030	Radial right thumb RD	-0.081
Ulnar left thumb RD	-0.081	Radial left thumb RD	-0.032
Ulnar right index RD	-0.046	Radial right index RD	-0.081
Ulnar left index RD	-0.037	Radial left index RD	-0.065
Ulnar right middle RD	-0.035	Radial right middle RD	-0.060
Ulnar left middle RD	-0.037	Radial left middle RD	-0.012
Ulnar right ring RD	-0.015	Radial right ring RD	-0.026
Ulnar left ring RD	-0.055	Radial left ring RD	-0.023
Ulnar right little RD	-0.102*	Radial right little RD	-0.091
Ulnar left little RD	-0.134**	Radial left little RD	-0.097

* $p < 0.05$; ** $p < 0.01$; RD: ridge density

Table 4: Correlation of ulna and radial fingerprint ridge density with body mass index based on gender

Body mass index (kg/m ²)	Correlation coefficient (r)		Body mass index (kg/m ²)	Correlation coefficient (r)	
	Male	Female		Male	Female
Variables			Variables		
Ulna right thumb RD	-0.027	-0.033	Radial right thumb RD	-0.133	-0.044
Ulna left thumb RD	-0.067	-0.091	Radial left thumb RD	-0.083	0.010
Ulna right index RD	-0.059	-0.038	Radial right index RD	-0.051	-0.102
Ulna left index RD	-0.024	-0.049	Radial left index RD	0.023	-0.118
Ulna right middle RD	-0.025	-0.043	Radial right middle RD	-0.043	-0.074
Ulna left middle RD	0.028	-0.085	Radial left middle RD	0.034	-0.042
Ulna right ring RD	-0.072	0.022	Radial right ring RD	-0.095	0.021
Ulna left ring RD	-0.061	-0.052	Radial left ring RD	-0.022	-0.025
Ulna right little RD	-0.046	-0.144	Radial right little RD	-0.093	-0.097
Ulna left little RD	-0.091	-0.165*	Radial left little RD	0.006	-0.174*

* $p < 0.05$, BMI: body mass index, RD: ridge density

Discussion

The role of genetic factors in embryogenesis of fingerprints necessitates its correlation with disease conditions that have genetic background [24]. Previous studies demonstrate the diagnostic potential of dermatoglyphics for certain diseases such as coronary artery disease, Klinefelter's syndrome, multiple sclerosis among others [12-13, 19]. This study sought to explore the correlation of fingerprint ridge density with BMI from selected tertiary institutions in Kano metropolis Nigeria. A significant relationship observed between the fingerprint ridge density and BMI in this study is in line with previous studied [17, 25]. In a study conducted on Hausa population, it was suggested that thumbprint ridge count correlated with BMI, hence recommended as a potential predictor of adiposity indices measured using BMI [26]. In an effort to determine the confounder effect of fingerprint ridge count, it was documented that ridge count correlated significantly with BMI [26, 25]. This led to the suggestion that BMI should be considered as covariate when comparing fingerprint ridge count between sexes and/or populations [26]. This study, therefore, further support the existence of correlation between fingerprints ridge counts/density with BMI. Despite the agreement between the present and previous studies [17, 26], some contrasting differences in the nature of the correlation were observed. For example, according to Adamu *et al.* [16] the correlation was significant with the thumbprints in males. But in the present study, the correlation was with the little digits with absence of correlation on the thumb digit. Therefore, based on this, it may be hypothesized that the correlation of BMI with ridge count exists but may occur at random with respect to digits. Different individuals or population may have specific digits

that exhibit the affinity to correlate with BMI. Additionally, gender may play a significant role in shaping the relationship between the variables across different types of digits. Therefore, some digits may explain existence of correlation for a particular sex compared to others, such as thumb for males [16] and little for females as reported by present study. Different areas (ulnar and radial) on the digits exhibited different potentials in the correlation of the ridge counts and BMI. This may be explained by the fact that different areas on the same digit respond differently to the developmental instruction [27]. This may account the differences in the correlation of fingerprint ridge density with other body variables including BMI. Therefore, it is crucial to explore further the mechanism that may explain the differences in the affinity of different areas on the same digits for better understanding of the existing correlations.

In addition to the fingerprint ridge counts, other features such as minutiae, ridge thickness, and pattern were found to correlate with BMI [17, 24]. This may explain the fact that the mechanism that control the formation of fingerprint features may also have influence on the genetic coding of the general body fat distribution measured using BMI. It was also documented that the high frequency of the arch pattern on the first right digits of the patients is peculiar to obese compared to the normal subjects [24]. This may also highlight the significance of temporary eminence, volar pads, associated with tips of the digits during 7th week of development as initial risk factor of obesity and its related disorders. The connection between radial fingerprints and BMI in females reported in the present study, might be due to the influence of the

volar pad, which determines fingerprint patterns during fetal development. Highly round symmetrical pads show whorls; less well-developed asymmetric pad shows loops, pad slanted to the right gives rise to loop opening to the left and vice versa whereas small indistinct pads (flat pad) give rise to arches [8].

Conclusion

There was a significant correlation between fingerprint ridge density and BMI especially among

females of tertiary institutions in Kano State, Nigeria. This study revealed that fingerprint ridge density may be used as a marker of an individual's BMI and also support the potential use of dermatoglyphic traits as non-invasive indicators of obesity risk.

Acknowledgements

We wish to thank all participants in this study. Also, the technical support provided by others is well appreciated.

References

1. Madrid NY, Mejia LF, Urrego JFG. Left knee septic monoarthritis in a pediatric patient due to shewanella putrefaciens: case report and literature review. *Ann Clin Microbiol Antimicrob* 2024; 23(1): 43.
1. Basavaraj Patil GV, Rafi M. Human age estimation through fingerprint. *Int J Innov Res Comput Commun Eng* 2015; 3(4): 3530.
2. Pechenkina EA, Benfer RA Jr, Vershoubskaya GG, Kozlov AI. Genetic and environmental influence on the asymmetry of dermatoglyphic traits. *Am J Phys Anthropol* 2000; 111(4): 531-543.
3. Kahn HS, Ravindranath R, Valdez R, Narayan KMV. Fingerprint ridge-count difference between adjacent fingertips (dR45) predicts upper-body tissue distribution: evidence for early gestational programming. *Am J Epidemiol* 2001; 153(4): 338-344.
4. Kücken M, Newell AC. A model for fingerprint formation. *Europhys Lett* 2004; 68(1): 141.
5. Schaumann B, Alter M. *Dermatoglyphics in Medical Disorders*. Springer Science & Business Media; 2012
6. Cummins H. The topographic history of the volar pads in the human embryo. *Contrib Embryol Carnegie Inst Wash* 2009; 20: 103-126.
7. Moorthy N, Rajathi T. Sexual Dimorphism from Palmprint Ridge Density among Malaysian Tamils for Person Identification. *J Krishna Inst Med Sci Univ* 2020; 9(1): 51-57.
8. Kaushal N, Kaushal P. Human identification and fingerprints: a review. *J Biomet Biostat* 2011; 2: 123.
9. Thute PP, Padole SV, Bakane BC, Fulmali DG, Sawal AN, Bakane AB. The study of dermatoglyphic pattern of thumb and its correlation with academic performance of medical students. *J Krishna Inst Med Sci Univ* 2023; 12(4): 111-121.
10. Igbigbi PS, Msamati BC, Ng'ambi TM. Plantar and digital dermatoglyphic patterns in Malawian patients with diabetes, hypertension and diabetes with hypertension. *Int J Diabetes Metab* 2001; 9(1-2): 24-31.
11. Chimne HD, Ksheersagar DD. Dermatoclyphic patterns in angiographically proven coronary artery disease. *J Anat Soc India* 2012; 61(2): 262-268.
12. Pahuja K, Agarwal SK. Analysis of the qualitative and quantitative dermatoglyphic traits in schizophrenia patients. *J Anat Soc India* 2012; 61(2): 269-272.
13. Sabanciogullari V, Cevik S, Karacan K, Bolayir E, Cimen M. Dermatoglyphic features in patients with multiple sclerosis. *Neurosciences (Riyadh)* 2014; 19(4): 281-285.
14. World Health Organization. *Obesity: preventing and managing the global epidemic: report of a WHO consultation*. Geneva: WHO; 2000.
15. Valiollah S. Determination of relationship between anthropometrical markers and lipid profile in respiratory patients. *Int Conf Environ Biomed Biotechnol* 2011: 16

16. Adamu LH, Ojo SA, Danborn B, Adebisi SS, Taura MG. Sex differences in facial asymmetry indices among Hausa ethnic group of Nigeria. *Ann Bioanthropol* 2016; 4(2):105.
17. Oladipo GS, Afolabi EO, Esomonu C. Dermatoglyphic patterns of obese versus normal-weight Nigerian individuals. *BiomedInt* 2010; 1(2).
18. Mundorff AZ, Bartelink EJ, Murad TA. Sexual dimorphism in finger ridge breadth measurements: a tool for sex estimation from fingerprints. *JForensic Sci* 2014; 59(4):891-897.
19. Syamsurizal S, Badriyya E, Putri S. Unique pattern of hypertension fingerprints. *Trop Genet* 2022; 2(2).
20. Norovsambuu O, Tsend Ayush A, Lkhagvasuren N, Jav S. Main characteristics of dermatoglyphics associated with schizophrenia and its clinical subtypes. *PLoS One* 2021; 16(6):e0252831.
21. Oladipo GS, Akanigha BE. Dermatoglyphic patterns in androgenetic alopecia in a southeastern Nigerian population. *JExp Clin Anat* 2005; 2:44-7
22. Lwanga SK, Lemeshow S. Sample size determination in health studies: a practical manual. Geneva: World Health Organization; 1991:10.
23. Pechenkina EA, Benfer RA Jr, Vershoubskaya GG, Kozlov AI. Genetic and environmental influence on the asymmetry of dermatoglyphic traits. *Am J Phys Anthropol* 2000; 111(4):531-43.
24. Adamu L, Taura M. Embryogenesis and applications of fingerprints: a review. *Int J Hum Anat* 2017; 1(1):1-8.
25. Polcerová L, Chovancová M, Králík M, Beňuš R, Klíma O, Meinerová T, Čuta M, Petrová ME. Radioulnar contrasts in fingerprint ridge counts: searching for dermatoglyphic markers of early sex development. *Am J Hum Biol* 2022; 34(5):e23695.
26. Nasir S, Salisu R, Rayyan M, Muhd U, Sa'id T, Asuku A, Taura M, Adamu L. Fingerprints white line counts (fWLC): an unfolding panacea of body composition estimation among students of selected tertiary institution in Kano State, Nigeria. *Dutse J Pure Appl Sci* 2022; 8(2b).
27. Mendelsohn A, Dasen J, Jessell T. Divergent Hox coding and evasion of retinoid signaling specifies motor neurons innervating digit muscles. *Neuron* 2017; 93(4):792-805.

***Author for Correspondence:**

Haruna Shuaibu Kumurya, Human Anatomy Unit, Faculty of Basic Health Sciences, Al-istiqama University, Sumaila, Kano, Nigeria Email: haruna.ana@ausumaila.edu.ng Telephone: +2347036230627

How to cite this article:

Haruna SK, Halima MU, Hassan I, Ahmad IM, Ibrahim MD, Maryam IS, Lawal JA, Isyaku I, Kabiru BU, Musa A, Lawan HA, Abdullahi YA, Magaji GT. Correlation of fingerprint ridge density and body mass index among Nigerians. *JKrishna Inst MedSci Univ* 2025; 14(2):63-70

Submitted: 25-Dec-2024 Accepted: 25-Feb-2025 Published: 01-April-2025