Original Article

Dermatoglyphic Patterns and Body Mass Indices among Medical Students in India: A Cross-sectional Study

Arun Singh, Archana Singh[1]

Department of Community Medicine, Rohilkhand Medical College and Hospital, Bareilly, [1]Department of Anatomy, Autonomous State Medical College, Pilibhit, Uttar Pradesh, India

Abstract

Introduction: Obesity is a disorder for which environment and genetic factors are responsible. Many genetical inherited disorders including obesity have been found to have an association with dermatoglyphics. The present study was done to know the dermatoglyphic patterns of fingerprints of obese and nonobese medical students. **Materials and Methods:** Fingers and palm prints of both the hands of 150 medical students of 18–24 years were collected with the help of ink pad on A4 size of paper. The fingers and palm prints were studied using handheld magnifying lens and their body mass index was calculated with the help of weight and height. **Results:** In the present cross-sectional study among 150 participants, 78 were male and 72 were female. In male participants, 46.15% were non-obese and 46.15% were obese, whereas 7.7% were underweight. Among 34 female participants, 47.22% were non-obese, 47.22% were obese, and 5.55% were underweight. In a total of 150 participants, the most common dermatoglyphic pattern was loop (49.73%) on the right side (in male it was whorl and in female loop) and whorl (48.27%) was on the left side (in male it was loop and in female it was whorl). In male participants with normal weight, the most common pattern was loop on the right side (49.45%) and whorl (48.33%) on the left side, whereas in nonobese female participants, whorl was the most common pattern on both right (48.24%) and left (50%) side. In obese male participants, whorl was the most common dermatoglyphic pattern on both the right (56.67%) and left side (51.11%), whereas in obese female participants, loop was the common pattern on both the side (57.64% in the right and 46.47% in the left). **Conclusions:** Whorls in both sides, i.e. the right and left hands palmer prints were most commonly found in obese males, whereas loops were most common in both the sides in obese females. Therefore, the presence of whorls and loops can be associated with the obesity in males and females, respectively, with the help of advanced studies to be carried out in the future and the generated hypothetical information can be tested.

Keywords: Body mass index, loop, obese, whorl

Introduction

The scientific study of patterns of fingerprints and palmar prints are collectively known as dermatoglyphics, its scientific study was initiated in the year 1892. The term was coined by Dr. Harold Cummins. He is known as the father of American fingerprint analysis.[1] Fingerprint is unique for an individual because epidermal ridges are determined genetically.[2] Nowadays dermatoglyphics are not only used for identification by forensic people but also used in many other medical and nonmedical fields, such as identification of uniqueness of left-handed person,[3] diagnosis of genetic disorder like Klinefelter syndrome,[4] Cri du chat syndrome, congenital blindness,[5] Noonan syndrome,[6] trisomy 13 (Patau syndrome), trisomy 18 (Edwards syndrome), trisomy 21 (Down syndrome),[7] and Turner syndrome[8] also to make the diagnosis in medical disorders such as in diabetes mellitus Type II,[9] Kanner's syndrome,[10,11] hypoparathyroidism,[12] and male cationic schizophrenia.[13] Recently, dermatoglyphics is used in career counseling (dermatoglyphics multiple intelligence test) to decide the suitability to study and to learn a particular discipline and also helps in deciding capability, skill, and efficiency for particular jobs.[14-16]

Submitted: 19-Feb-2024 **Revised:** 21-Mar-2024
Accepted: 27-Mar-2024 **Published:** 29-Apr-2024

Access this article online

Quick Response Code:

Website: www.actamedicainternational.com

DOI: 10.4103/amit.amit_20_24

Address for correspondence: Dr. Arun Singh, Department of Community Medicine, Rohilkhand Medical College Campus, Pillibhit Byepass Road, Bareilly - 243 006, Uttar Pradesh, India.
E-mail: arunspm@gmail.com

How to cite this article: Singh A, Singh A. Dermatoglyphic patterns and body mass indices among medical students in India: A cross-sectional study. Acta Med Int 2024;11:60-6.

Obesity is a disorder for which environment and genetic factors are responsible. Many genetical inherited disorders such as congenital heart defects, schizophrenia, alopecia, mental retardation, diabetes mellitus, and obesity have been found to have an association with dermatoglyphics.[17-19] Hence, the present study was carried out to know the dermatoglyphic patterns (palmer prints and fingerprints) in different body mass index (BMI) indices groups (obese and nonobese) medical students currently studying in a Medical College in India.

Materials and Methods

Study design and Study settings

This cross-sectional study was done on 150 medical students in a Medical College in Northern India, after taking the Ethical Clearance from IRB and or IEC (IEC/63/2019/SEP) and after taking consent from participants, i.e. MBBS students, the finger and palmar prints were taken and then, they were subjected to anthropometric measurement and subsequently the BMI was calculated and cross tabulated with the dermatoglyphic patterns of the medical students.

Sample size was 50 ($n = Z^2 \times$ standard deviation $[SD^2]/E^2$: Z was 1.96 (95% confidence interval), SD = 1.8,[20] and E was 5%).

Material required

Ink, ink pad, soap, water, towel, white bond paper, hand lens, demographic information of participants such as name, date of birth, date of test, course pursuing and hand lens and for BMI calculation, weighing machine and stadiometer.

Method of taking fingerprint

The palms and fingerprints of both the hands of the study subjects were recorded by the ink and roller method, as was suggested by Cummins *et al*.[21]

The hands of the subjects were first cleaned with soap and water and dried with a towel before the recording of palm prints. A small amount of ink was dispensed onto the inking slab and it was thoroughly spread. The subject was made to stand in front of the inking plate. The palmar surface of the right hand was placed on the inking slab and pressed gently. The completely inked palmar surface was then gently pressed on a clean, white bond paper and it was removed immediately. The same procedure was repeated for the left hand. In taking the rolled impressions of individual fingers, the fingers were rolled laterally on the ink slab and then placed on a white paper. The fingers were printed by rolling them from the radial to the ulnar side to include the patterns. The palms and fingerprints of the individuals were studied with the help of a magnifying lens.

Body mass index calculation

To categorize the participants into obese and nonobese, BMI was calculated by the height and weight of each participant. Participants having BMI (18.5–24.5) m^2/kg were non-obese and who has BMI >25 m^2/kg classified as obese.[22]

Data analysis

All the data were entered into to Excel sheet and analysis was done using SPSS software version 22.0 (IBM Corp. 2013. Armonk, New York). Paired-*t*-test was used to compare the means of "ab" ridge counts, "atd" angle of both the hands.

Inclusion criteria

1. Undergraduate students of the medical field (MBBS).

Exclusion criteria

1. Medical students not giving consent for participation
2. Medical students having skin lesions or scar on the palmar aspect of their hand.

Results

In the present cross-sectional study among 150 participants, 78 were male and 72 participants were female. Out of 78 male participants, 46.15% were non-obese and 46.15% were obese, whereas 7.7% were underweight. Among 34 female participants, 47.22% were non-obese, 47.22% were obese, and 5.55% were underweight [Table 1].

In a total of 150 participants, on the right fingerprints, the most common dermatoglyphic pattern was loop (49.73%) followed by whorl (47.87%), whereas on the left side, the most common dermatoglyphic pattern was whorl (48.27%) followed by loop (46.15%) [Table 2].

In right fingerprints, among male participants, more common dermatoglyphic pattern was whorl (51.02%), and in among female participants, it was loop (52.23%). On the left side, in males, the most common dermatoglyphic pattern was loop (48.71%), whereas, in females, whorl (48.27%) was the most common pattern. On comparison of the patterns in fingerprints of males and females, the incidence of all the dermatoglyphic patterns was different in both the genders of participants which was not statistically found to be significant except the incidence of arches of left sides of the fingers of male and female significantly associated statistically [$P < 0.05$, Table 2].

The most common pattern found in the fingerprint of nonobese participants was whorl, on both the right (48.29%) and left (49.14%) sides, in obese participants, loop was the most common pattern on both the side (50.29% in the right and 47.7% in the left) also among underweight participants, loop was the common pattern on both the sides [Table 3].

Table 1: Gender-wise distribution of body mass index group among the participants

BMI	Male, *n* (%)	Female, *n* (%)	Total
Normal	36 (46.15)	34 (47.22)	70
Overweight	36 (46.15)	34 (47.22)	70
Underweight	6 (7.70)	4 (5.55)	10
Total	78	72	150

BMI: Body mass index

Table 2: Distribution of dermatoglyphic patterns in fingerprints of male and female participants

Dermatoglyphic patterns	Right side					Left side				
	Male (n=78), n (%)	Female (n=72), n (%)	Total, n (%)	t	P	Male (n=78), n (%)	Female (n=72), n (%)	Total, n (%)	t	P
Loop	185 (47.44)	188 (52.23)	373 (49.73)	−1.03	0.31	190 (48.71)	156 (43.33)	346 (46.15)	0.52	0.61
Arch	6 (1.54)	12 (3.33)	18 (2.4)	−1.81	0.07	12 (3.08)	30 (8.33)	42 (5.6)	−2.197	0.03
Whorl	199 (51.02)	160 (44.44)	359 (47.87)	1.52	0.13	188 (48.21)	174 (48.34)	362 (48.27)	0.652	0.52
Total (n×5)	390	360	750	-	-	390	360	750	-	-

Table 3: Distribution of dermatoglyphic patterns in fingerprints of participants with different body mass index groups

Dermatoglyphic patterns	Right side			Left side		
	Normal (n=70), n (%)	Overweight (n=70), n (%)	Underweight (n=10), n (%)	Normal (n=70), n (%)	Overweight (n=70), n (%)	Underweight (n=10), n (%)
Loop	167 (47.71)	176 (50.29)	30 (60)	155 (44.29)	167 (47.71)	24 (48)
Arch	14 (4)	2 (0.57)	2 (4)	23 (6.57)	17 (4.86)	2 (4)
Whorl	169 (48.29)	172 (49.14)	18 (36)	172 (69.14)	166 (47.43)	24 (48)
Total (n×5)	350	350	50	350	350	50

In male participants with normal weight, the most common pattern was loop on the right side (49.45%) and whorl (48.33%) on the left side, whereas in nonobese female participants, whorl was the most common pattern on both the right (48.24%) and left (50%) sides [Table 4].

In obese male participants, whorl was the most common dermatoglyphic pattern on both the right (56.67%) and left sides (51.11%), whereas in obese female participants, loop was the common pattern on both the side (57.64% in the right and 46.47% in the left) [Table 4].

Incidence of dermatoglyphic pattern on individual finger were as follows-

In male participants, whorl was the most common pattern seen in both side of the thumb, index, and ring finger, whereas loop was the most common pattern seen in the middle and little fingers of both the side. In female participants, whorl was most commonly seen in the thumb and ring fingers on both the side, whereas loop was the most common pattern seen in the index, middle, and ring fingers of both the side [Tables 5 and 6].

In male participants with normal weight, whorl was the most common pattern in the thumb, left index, and ring finger, and loop was the most common pattern in the right index, both sides middle and little finger. In normal-weight female participants, whorl is the most common pattern in the thumb and ring finger of both sides, loop was the common pattern seen in the index, middle, and little finger [Tables 7 and 8].

In overweight (obese) male participant, whorl was the common pattern in the thumb, right index, and ring finger, whereas loop was the common pattern in the left index and both the right and left middle and little fingers. In obese female participants, whorl was the common dermatoglyphic pattern in the thumb and ring finger, whereas loop was the common pattern seen in the index, middle, and little finger of both the sides [Tables 7 and 8].

The mean a–b ridge count and atd angle of male and female participants are given in Table 9, mean values of a–b ridge count and atd angle were higher in male in comparison to females.

The mean a–b ridge count and atd angle of normal and obese participants are shown in Table 10, which was higher in obese participants in comparison to normal-weight participants.

Discussion

Dermatoglyphic patterns of fingertips are unique and helpful in the identification of certain genetic and systemic disorders such as obesity.[18,19,23]

Distribution of dermatoglyphics pattern in male and female

In the present study, whorl was the most common pattern in males (49.6%), whereas in female incidence of the loop (47.77%) was higher. In Nepalese's medical student incidence of loop was higher in males (957.9%) as well as in females (54.3%) followed by whorl (37% in males and 38.6% in females).[24] Amit and Anjulika[25] in Indian medical students, reported a higher incidence of loops, both in males (48.43%) and females (59.71%) followed by whorls (42.7% in males and 32.43% in females). Smail *et al*.[26] (Iraq) also reported a higher incidence of loop pattern in both males (57.95%) and females (58.83%) followed by whorl (36.5% in males and 39% in females).

Distribution of dermatoglyphic patterns in different body mass index groups

In the present study in obese as well as normal-weight male participants, loop was the most common pattern seen in the

Table 4: Distribution of dermatoglyphic pattern in fingerprint of males and females with different body mass index groups

Dermatoglyphic patterns	Male (*n*=78)						Female (*n*=72)					
	Right side			Left side			Right side			Left side		
	Normal weight (*n*=36), *n* (%)	Overweight (36), *n* (%)	Underweight (*n*=6), *n* (%)	Normal weight (*n*=36), *n* (%)	Overweight (36), *n* (%)	Underweight (*n*=6), *n* (%)	Normal weight (*n*=34), *n* (%)	Overweight (*n*=34), *n* (%)	Underweight (*n*=4), *n* (%)	Normal weight (*n*=34), *n* (%)	Overweight (*n*=34), *n* (%)	Underweight (*n*=4), *n* (%)
Loop	89 (49.45)	78 (43.33)	18 (60)	82 (45.56)	88 (48.89)	20 (66.67)	78 (45.88)	98 (57.64)	12 (60)	73 (42.94)	79 (46.47)	4 (20)
Arch	4 (2.22)	0	2 (6.67)	11 (6.11)	0	2 (6.67)	10 (5.88)	2 (1.18)	0	12 (7.06)	18 (10.59)	0
Whorl	87 (48.33)	102 (56.67)	10 (33.33)	87 (48.33)	92 (51.11)	8 (26.66)	82 (48.24)	70 (41.18)	8 (40)	85 (50)	73 (42.94)	16 (80)
Total (n×5)	180 (100)	180 (100)	30 (100)	180 (100)	180 (100)	30 (100)	170 (100)	170 (100)	20 (100)	170 (100)	170 (100)	20 (100)

middle and little finger (of both the right and left sides), whereas whorl was the common pattern in the thumb and ring finger (of both sides), but in the index finger of obese male, the loop was the common pattern in the right index and whorl was in the left index finger and in normal weight male participants loop was commonly seen in the right side and whorl was common on the left side. In female, obese as well as normal-weight participants loop was the most common pattern seen in the index, middle, and little finger of both the right and left sides, and the incidence of the whorl was higher in the thumb and ring fingers of both the sides.

Bhardwaj *et al*.[27] reported that the loop was the common pattern in normal-weight participants in all the fingers, whereas in obese participants, loop was common in the middle, ring, and little finger, the arch was commonly seen in the thumb and the whorl was the common pattern in the index fingers.

Shivakumar *et al*.[28] reported a pattern in the thumb and index finger only, in obese participants whorl was the most common pattern in the thumb on both sides (51% in the right and 79% in the left), whereas in the index finger incidence of the loop was higher on the right side (83%) and the arch was higher on the left side (74%). In normal-weight participants, whorl was the most common pattern seen in the right thumb (73%) and left index (53%), the loop was the most common pattern seen in the left thumb (73%) and the arch was in the right index (48%) finger.

Oladipo *et al*.,[20] in Nigerian individual, reported that in obese male participants loop was the most common pattern seen in the left thumb, right index, both sides of the middle, ring, and little finger, whereas in incidence of arch was higher and in right thumb and left index. In normal-weight male participants, loop was the most common pattern in both sided thumb, index, middle little, and left ring fingers, whereas in the right ring finger, whorl was the most common pattern. In obese female loop was the most common pattern in both side ring and little finger, right middle finger, left thumb, and left index finger, whereas the incidence of whorl was higher in the right index and left middle finger and the incidence of the arch was higher in the right thumb. In normal-weight female participants, loop was the most common pattern on both sides of all the fingers.[20]

'a-b ridge' count and 'atd' angle

In the present study, both a–b ridge count and atd angle were higher in male participants and in obese participants [Tables 9 and 10]. Oladipo *et al*.[20] in the Nigerian population and Bhardwaj *et al*.[27] in the Indian population also reported higher mean values of a–b ridge count and atd angle in obese participants.

Conclusions

In the obese participants, incidence of loop was higher and in normal-weight participants, incidence of whorl was higher. In obese male participants, incidence whorl was the most common pattern, whereas in female obese participants, loop was the

Table 5: In male participants distribution of dermatoglyphic pattern in individual fingers of the right and left sides

Male (*n*=78)	Right thumb, *n* (%)	Left thumb, *n* (%)	Right index, *n* (%)	Left index, *n* (%)	Right middle, *n* (%)	Left middle, *n* (%)	Right ring, *n* (%)	Left ring, *n* (%)	Right little, *n* (%)	Left little, *n* (%)
Loop	10 (12.82)	16 (20.51)	38 (48.72)	30 (38.46)	54 (69.23)	56 (71.80)	28 (35.90)	32 (41.03)	54 (69.23)	56 (71.80)
Arch	2 (2.56)	4 (5.13)	2 (2.56)	10 (12.82)	2 (2.56)	2 (2.56)	0	0	0	0
Whorl	66 (84.62)	58 (74.36)	38 (48.72)	38 (48.72)	22 (28.21)	20 (25.64)	50 (64.10)	46 (58.97)	24 (30.77)	22 (28.20)

Table 6: In female participants distribution of dermatoglyphic pattern in individual fingers of the right and left sides

Female (*n*=72)	Right thumb, *n* (%)	Left thumb, *n* (%)	Right index, *n* (%)	Left index, *n* (%)	Right middle, *n* (%)	Left middle, *n* (%)	Right ring, *n* (%)	Left ring, *n* (%)	Right little, *n* (%)	Left little, *n* (%)
Loop	14 (19.44)	10 (13.89)	42 (58.33)	36 (50)	56 (77.78)	36 (50)	26 (36.11)	30 (41.67)	50 (69.44)	46 (63.89)
Arch	2 (2.78)	6 (8.33)	6 (8.33)	12 (16.67)	2 (2.78)	10 (13.16)	2 (2.78)	0	0	2 (2.78)
Whorl	56 (77.78)	56 (77.78)	24 (33.33)	24 (33.33)	14 (19.44)	26 (36.11)	44 (61.11)	42 (58.33)	22 (30.56)	24 (33.33)

Table 7: Distribution of dermatoglyphic patterns in fingerprints of individual fingers of male participants with different body mass index group

BMI	Dermatoglyphicpatterns	Right thumb, *n* (%)	Left thumb, *n* (%)	Right index, *n* (%)	Left index, *n* (%)	Right middle, *n* (%)	Left middle, *n* (%)	Right ring, *n* (%)	Left ring, *n* (%)	Right little, *n* (%)	Left little, *n* (%)
Normal weight (*n*=36)	Loop	2 (5.56)	10 (27.78)	20 (55.56)	10 (27.78)	26 (72.22)	26 (72.22)	14 (38.89)	13 (36.11)	26 (72.22)	24 (66.67)
	Arch	2 (5.56)	4 (11.11)	0	4 (11.11)	2 (5.56)	2 (5.56)	0	1 (2.78)	0	0
	Whorl	32 (88.88)	22 (61.11)	16 (44.44)	22 (61.11)	8 (22.22)	8 (22.22)	22 (61.11)	22 (61.11)	10 (27.78)	12 (33.33)
Overweight (*n*=36)	Loop	6 (16.67)	4 (11.11)	16 (44.44)	18 (50)	24 (66.67)	26 (72.22)	10 (27.78)	14 (38.89)	22 (61.11)	26 (72.22)
	Arch	0	0	0	4 (11.11)	0	0	0	0	0	0
	Whorl	30 (83.33)	32 (88.88)	20 (55.56)	14 (38.89)	12 (33.33)	10 (27.78)	26 (72.22)	22 (61.11)	14 (38.89)	10 (27.78)
Underweight (*n*=6)	Loop	2 (33.33)	2 (33.33)	2 (33.33)	2 (33.33)	4 (66.67)	4 (66.67)	4 (66.67)	6 (100)	6 (100)	6 (100)
	Arch	0	0	2 (33.33)	2 (33.33)	0	0	0	0	0	0
	Whorl	4 (66.67)	4 (66.67)	2 (33.33)	2 (33.33)	2 (33.33)	2 (33.33)	2 (33.33)	0	0	0

BMI: Body mass index

Table 8: Distribution of dermatoglyphic patterns in fingerprints of individual fingers of female participants with different body mass index group

BMI	Patterns	Right thumb, *n* (%)	Left thumb, *n* (%)	Right index, *n* (%)	Left index, *n* (%)	Right middle, *n* (%)	Left middle, *n* (%)	Right ring, *n* (%)	Left ring, *n* (%)	Right little, *n* (%)	Left little, *n* (%)
Normal weight (*n*=34)	Loop	6 (17.65)	4 (11.77)	16 (47.05)	20 (58.82)	22 (64.71)	14 (41.18)	10 (29.41)	16 (47.05)	24 (70.59)	19 (50.88)
	Arch	2 (5.88)	0	4 (11.77)	2 (5.88)	2 (5.88)	8 (23.53)	2 (5.88)	0	0	2 (5.88)
	Whorl	26 (76.47)	30 (88.23)	14 (41.18)	12 (35.29)	10 (29.41)	12 (35.29)	22 (64.71)	18 (52.95)	10 (29.41)	13 (38.23)
Overweight (*n*=34)	Loop	8 (23.53)	6 (17.65)	22 (64.71)	14 (41.18)	30 (88.23)	22 (64.71)	14 (41.18)	14 (41.18)	24 (70.59)	24 (70.59)
	Arch	0	6 (17.65)	2 (5.88)	10 (29.41)	0	2 (5.88)	0	0	0	0
	Whorl	26 (76.47)	22 (64.71)	10 (29.41)	10 (29.41)	4 (11.77)	10 (29.41)	20 (58.82)	20 (58.82)	10 (29.41)	10 (29.41)
Underweight (*n*=4)	Loop	0	0	4 (100)	2 (50)	4 (100)	0	2 (50)	0	2 (50)	2 (50)
	Arch	0	0	0	0	0	0	0	0	0	0
	Whorl	4 (100)	4 (100)	0	2 (50)	0	4 (100)	2 (50)	4 (100)	2 (50)	2 (50)

BMI: Body mass index

Table 9: Mean a–b ridge count and "atd" angle in male and female participants

	Right		Left	
	a–b count	atd angle	a–b count	atd angle
Male (*n*=78)	45.3	42.26	45.08	42.31
Female (*n*=72)	43.67	40.94	43.11	41.7

Table 10: Mean a–b ridge count and "atd" angle in participants with different body mass index groups

BMI	Total	Right		Left	
		Mean ab count	Mean atd angle	Mean ab count	Mean atd angle
<18.50 (underweight)	10	44.6	40.2	46.6	41.8
18.50–24.99 (normal)	70	43.09	40.66	45.51	40.8
>25 (overweight)	70	44.86	41.26	46	43.26

BMI: Body mass index

most common pattern. In normal-weight male participants, loop was the common pattern seen on the right side and whorl on the left side and in normal-weight female participants whorl was the most common pattern.

Acknowledgment

We are sincerely thankful to the second and third-phase MBBS student of the 2020 and 2021 batches for their participation.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Penrose LS, Ohara PT. The development of the epidermal ridges. J Med Genet 1973;10:201-8.
2. Crawford MH, Duggirala R. Digital dermatoglyphic patterns of Eskimo and Amerindian populations: Relationships between geographic, dermatoglyphic, genetic, and linguistic distances. Hum Biol 1992;64:683-704.
3. Sinha CK, Meel M, Bayan B. Using dermatoglyphics pattern to identify the left handed unique pattern and its biological significance-if any. World Appl Sci J 2012;20:1107-13.
4. Komatz Y, Yoshida O. Finger patterns and ridge counts of patients with Klinefelter's syndrome (47, XXY) among the Japanese. Hum Hered 1976;26:290-7.
5. Viswanathan G, Singh H, Ramanujam P. Dermatoglyphic analysis of palmar print of blind children from Bangalore. J Ecotoxicol Environ Monit 2002;12:49-52.
6. Rott HD, Schwanitz G, Reither M. Dermatoglyphics in noonan's syndrome (author's transl). Acta Genet Med Gemellol (Roma) 1975;24:63-7.
7. Rajangam S, Janakiram S, Thomas IM. Dermatoglyphics in down's syndrome. J Indian Med Assoc 1995;93:10-3.
8. Reed T, Reichmann A, Palmer CG. Dermatoglyphic differences between 45, X and other chromosomal abnormalities of turner syndrome. Hum Genet 1977;36:13-23.
9. Flucher BE, Obermair GJ, Tuluc P, Schredelseker J, Kern G, Grabner M. The role of auxiliary dihydropyridine receptor subunits in muscle. J Muscle Res Cell Motil 2005;26:1-6.
10. Bowman EP. Asperger's syndrome and autism: The case for a connection. Br J Psychiatry 1988;152:377-82.
11. Langenbeck U, Varga I, Hansmann I. The predictive value of dermatoglyphic anomalies in the diagnosis of fra (X)-positive Martin-Bell syndrome (MBS). Am J Med Genet 1988;30:169-75.
12. Preus M, Fraser FC. Dermatoglyphics and syndromes. Am J Dis Child 1972;124:933-43.
13. Moore KL, Darlley AF, Anne MRA. Clinically Oriented Anatomy. 6th ed. Ontario, Canada: Wolters Kluwer/Lippincott Williams and Wilkins; 2012. p. 771.
14. Meera *P* Abhimanyu, Dr. Wayne Bottiger, Dr. GD Singh. An exploratory study about client satisfaction in dermatoglyphics multiple intelligence test. Int J Appl Res 2016;2:802-6.
15. Gardner H, Hatch T. Multiple intelligences go to school: Educational implications of the theory of multiple intelligences. Educ Res 1989;18:4.
16. Gardner H. Frames of Minds. The Theory of Multiple Intelligence. New York: Basic Books. Google Scholar; 1983.
17. Oladipo GS, Afolabi EO, Esomonu C. Dermatoglyphic patterns of obese versus normal-weight Nigerian individuals. Biomed Int 2010;1:66-9.
18. Umana U, Ronke R, Timbuak J, Ibegbu A, Musa S, Ikyembe D, *et al*. Dermatoglyphic and cheiloscopic patterns among diabetic patients: A study in Ahmadu Bello University Teaching Hospital Zaria, Nigeria. J Biol Life Sci 2013;4:206-14.
19. Umana UE, Netete BV, Timbuak JA, Ibegbu AO, Musa SA, Hamman WO. Dermatoglyphics and cheiloscopy pattern in hypertensive patients: A study in Ahmadu Bello University Teaching Hospital, Zaria, Nigeria and Environs. Int J Sci Res Publ 2014;4:1-5.
20. Oladipo GS, Afolabi EO, Esomonu C. Dermatoglyphic patterns of obese versus normal-weight Nigerian individuals. Nigerian individuals. Biomed Int 2010;1: 66-9.
21. Cummins H, Keith HH, Midlo C, Montgomery RB, Wilder HH, Wilder IW. Revised methods of interpreting and formulating palmar dermatoglyphics. Am J Phys Anthropol 1929;12:415-73.
22. Quetelet LA. Physique Sociale. Vol 2. Brussels, Belgium: C. Muquardt; 1869: p. 92.
23. Saad WM, Kamel AH, Hassan FZ, Elotiefy MA. Genetic studies on the inheritance of lip prints in cleft lip and palate. Egypt J Plast Reconstr Surg 2005;29:9-12.
24. Katwal B, Timsinha S, Limbu BK, Pant MP. Fingerprint analysis and gender predilection among medical students of Nepal Medical College and Teaching Hospital. Int J Res Rev 2017;4:62-6.
25. Amit AM, Anjulika AM. Study of fingerprint patterns among medical students in Vidarbha Region, India. Int J Anat Res 2015;3:1043-5.
26. Smail HO, Smail KA, Amin SO. Relationship between pattern of fingerprints and obesity. J Exp Molec Biol 2021;21:27-33. Available from: https://www.jemb.bio.uaic.ro/index.php/jemb/article/view/47. [Last accessed on 2024 Feb 10].
27. Bhardwaj N, Bhardwaj P, Tewari V, Siddiqui MS. Dermatoglyphic analysis of fingertip and palmer print patterns of obese children. Int J Med Sci Public Health 2015;4:946-9.
28. Shivakumar HG, Nandini DB, Mohan Kumar KP, Selvamani M, Priya NK, Madhushankari GS. Cheiloscopy and dermatoglyphics in normal and obese individuals: A study in Indian subpopulation. J Oral Maxillofac Pathol 2021;25:61-7.