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Original Article

Dermatoglyphic Patterns and Academic Performance: A Gender-Based Analysis Among Undergraduate Medical Students

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ABSTRACT

Background: Dermatoglyphics offers a non-invasive window into genetically determined neurological architecture. Evidence suggests correlations between fingerprint pattern types and cognitive performance, yet gender-stratified analyses among medical students remain limited. Objective: To determine the distribution of dermatoglyphic patterns across high, average, and low academic performance categories and examine gender-based differences among undergraduate medical students.

Material and Methods: The present Study was conducted in the department of Anatomy, Integral Institute of Medical Sciences, Lucknow, Uttar Pradesh, India on 150 Undergradutae medical students of 1st year. Fingerprint obtained using Standard Ink Method. The Parameters studied in this study included Arch, Whorl and Loop. The academic performance of students was based on the marks obtained in National Eligibility Cum Entrance Test(NEET).

Statistics: Chi-square tests assessed gender-based pattern associations per digit.

Results: Loop was the dominant pattern across all categories. Significant gender differences were found in the left-hand Middle and Ring fingers of high scorers ($p=0.006$ and $p=0.002$) and the right-hand index finger among average scorers. A highly significant difference was observed in the left-hand Little finger of average scorers ($p<0.001$). Low scorers showed no significant gender-based differences.

Conclusion: Dermatoglyphic pattern distributions show meaningful gender-specific variations in high and average academic performers. Loops frequency correlates with higher achievement. These findings support dermatoglyphics as a potential early screening tool in medical education.

Keywords*: dermatoglyphics, fingerprint patterns, academic performance, medical students, gender differences, arch, whorl, loop.*

INTRODUCTION

Dermatoglyphics, derived from greek words derma (skin),and glyphics(curved), referes to the scientific study of the pattern of epidermal ridges on the fingertips, palms and soles of the feet. These patterns are genetically determined and develop during 13th to 19th weeks of fetal life.Their permanence, uniqueness and genetic basis have made them a subject of sustained scientific analysis across multiple disciplines including anatomy, forensic medicine, and genetics.

The history of dermatoglyphics dates to 1684, when Nehemiah Grew described the unique patterns found on people's fingertips in his publication presented to the London's Royal College of Physicians [1]. Further, G. Bidloo used detailed drawings to show fingerprints. In 1685, in his book Anatomia Humani Corporis (Amsterdam: Utrecht Edition 1685). In 1788, the original proponent of fingerprint analysis [2], J.C.A. Mayer, made the claim that each person's skin ridge pattern is distinct, But some people are more alike than others[3]. Later, In 1823, J.E. Purkinje was the first who classified patterns into nine categories[4]. To prevent forgery of native contracts in 1858, W.J. Herschel, chief magistrate of the Hooghly

district in West Bengal, India, was the first to use fingerprints [5] . Galton's 1892 published book 'Fingerprints' classified patterns into arches, loops and whorls, proving their uniqueness and permanence, and establishing the scientific foundation of dermatoglyphics [6] . Harold Cummins, widely regarded as the founder of dermatoglyphics, first used the term in 1926, and firstly used dermatoglyphics in clinical medicine [7,8]. In 1943, He also published a book 'An introduction to Dermatoglyphics' with the help of Midlo [9].

Scientific data indicates a strong correlation between dermatoglyphics and cerebral functions, as the development of the brain and the epidermal ridges of the hand from embryonic ectoderm transpires concurrently from ectoderm during second trimester. [10,11] Cognitive talents are predominantly associated with the cerebral cortex [12]. Students' cognitive engagement including verbal skills, auditory processing, and memory, is manifested in academic assessments (both qualitative and quantitative). Students' academic brain activity is reflected in academic evaluations (qualitative and quantitative evaluation). Numerous studies demonstrate a correlation between particular dermatoglyphic patterns and intellect, as well as academic achievement [13,14,15]. The assessment of intelligence is a significant aspect of psychology that plays a crucial function in society. Individuals with a low intelligence quotient (IQ) encounter difficulties in learning, reasoning, and assimilating new information, necessitating care. Low IQ is associated with genetic disorders[16,17].
Dermatoglyphics are mainly classified into three groups (Fig.-3):

1.ARCHES 2. LOOPS 3.WHORLS

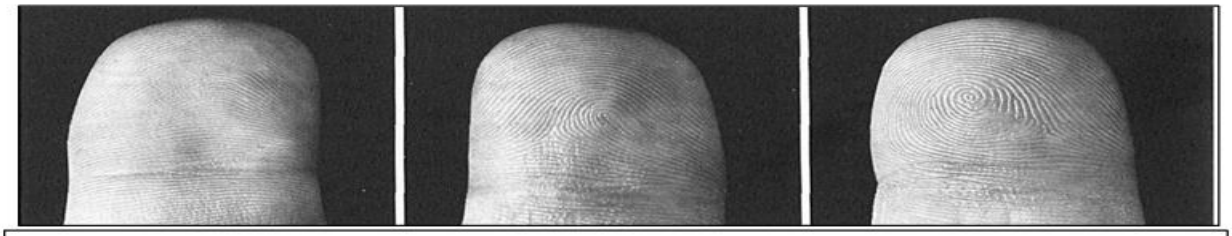


Fig. 1: Pictures of fingertips showing three basic patterns, (from left to right) : Arch, loop and whorl (From Miller. J.R & Giroux.J.)

MATERIALS AND METHOD

The present study was conducted on 1st Year Undergraduate medical students (MBBS) of Integral Institute of Medical Sciences & Research (IIMSR),Lucknow, in the Department of Anatomy,on (2024-2025) Batch. Informed consent was obtained after explaining the details of the study.

Inclusion criteria: Students enrolled in 1st Year of Bachelor of Medicine and Bachelor of Surgery (MBBS), batch of (2024-25) at IIMSR,Lucknow.

Exclusion criteria: Students with skin diseases involving fingertip and those with deformities linked to the fingertips of both hands.

Sample size: A total of 150 enrolled undergraduate medical students of 1st Year were subjected to the research , out of 150 participants, 70 males and 80 females MBBS students.

Material Requied: White papers , Black duplicating ink, Ink pad, Glass slab, Pencil, Magnifying hand lens,Wet wipes.
Study Procedure : The fingerprints of both hands of medical students were taken by using standard Ink method with consent. The prints with the help of magnifying hand lens, the fingertip of both hands of medical students were observed and noted down. .The parameters analysed to study the academic performance of medical students were the marks scored in NEET, which obtained and verified from the NEET marks list avaliable with students.

The Parameters studied were Qualitative, namely :
1. ARCHES 2. LOOPS 3.WHORLS
Galton (1892), classified patterns into three types[6]:
Arches – about 5% , Loops – majority, 55 – 65% , Whorls – 30 -35%

STATISTICAL ANALYSIS: Gathered data was input into an MS-EXCEL spreadsheet and subsequently processed with Azure Data Factory for ingestion and transformation. Statistical analysis was performed using SPSS. A p-value less than 0.05 ($P < 0.05$) was considered statistically significant.

RESULTS:

Study Population: The study included 150 undergraduate medical students, consisting of 70 males and 80 females. Dermatoglyphic patterns of all ten fingertips (1500 prints) were analyzed and classified into Arches , Loops , Whorls. The

study showed a predominance of female participants of 53.3% and male students of 46.7%. This indicates that female participants constituted a slightly higher proportion of the study compared to males. So, the study had a female predominance. (Table 1 & Fig.2)

TABLE-01 & FIG.2: Study population (Gender based)

GENDER	FREQUENCY	PERCENTAGE
Male	70	46.7%
Female	80	53.3%
Total	**150**	**100%**

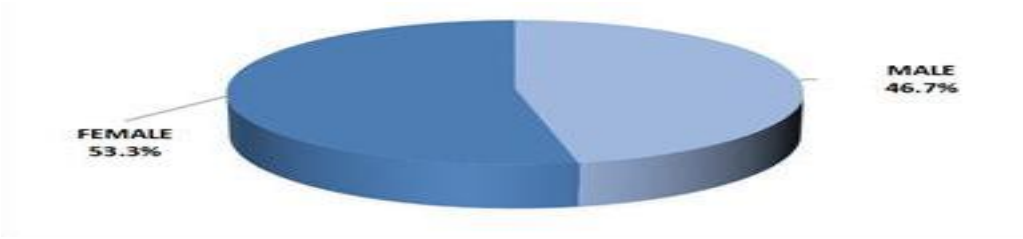
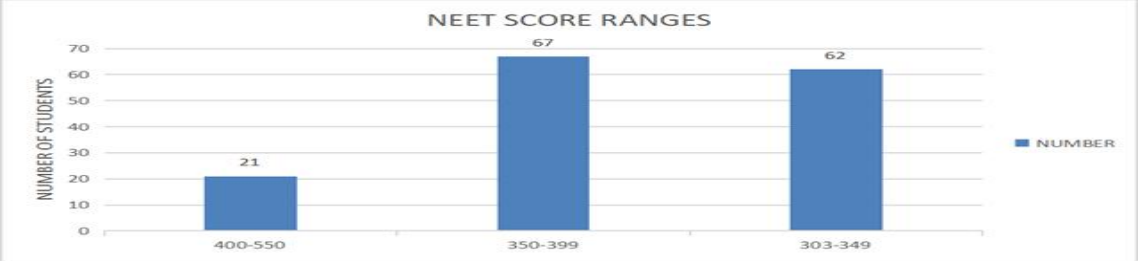


Fig. Gender distribution of the study population(n=150)

Academic Performance Distribution:In this study, 21 students scored between (400-550) considered as High performers, 67 students scored between (350-399) considered as Average performers and 62 students scored between (303-349) as low performers.(Table 2 & Fig.3)

TABLE-02 & FIG. 3: : Academic categories distribution of study population:

NEET SCORE RANGE	CATEGORIES	FREQUENCY
400-550	HIGH	21
350-399	AVERAGE	67
303-349	LOW	62
Total		**150**



Pattern Distribution by Academic performance category and hand

Table 3-8 presents the digit-wise dermatoglyphic pattern distribution for male and female students in each performance category, separately for right and left hands. Each table includes Chi-square value, P- value and significance remark.(NS= Not significant, S= Significant at $p < 0.05$, HS= Highly significant at $p < 0.05$).

Table-03; Distribution of dermatoglyphic Patterns in High scored students-Right hand

DIGITS	MALE (A/W/L)	FEMALE (A/W/L)	X^2 VALUE	P-VALUE	REMARK
THUMB	1/3/4	1/6/6	0.222	0.895	NS
INDEX	1/6/1	3/5/5	2.721	0.256	NS
MIDDLE	1/2/5	2/5/6	0.551	0.759	NS
RING	0/5/3	0/8/5	0.002	0.965	NS
LITTLE	0/3/5	1/4/8	0.683	0.711	NS

Interpretation -In high scored students, statistically insignificant association was observed between gender and pattern type across all five digits of the right hand($p > 0.05$). loops were the dominant pattern in the Thumb and Little fingers, while Whorls predominated in the Ring and Index fingers for both males and females. This suggests that the gender does not influence fingerprint pattern distribution on the right hand of academically high performing students."

Table-04 Distribution of dermatoglyphic Patterns in High scored students-Left hand

DIGITS	MALE (A/W/L)	FEMALE (A/W/L)	X^2 VALUE	P-VALUE	REMARK

THUMB	1/3/4	2/7/4	0.788	0.675	NS
INDEX	2/4/2	4/4/5	0.808	0.668	NS
MIDDLE	0/6/2	1/1/11	10.189	0.006	S
RING	0/8/0	0/4/9	9.692	0.002	S
LITTLE	0/3/5	1/4/8	0.683	0.711	NS

Interpretation -In high scored students, statistically significant associations observed between gender and pattern type at Middle (X^2= 10.189, p= 0.006) and Ring finger (X^2=9.692, p=0.002) of the left hand, while the Thumb, Index, Little fingers were statistically insignificant (p>0.05) difference found in both genders.These findings suggests a possible laterality effect in dermatoglyphic gender differences among high academic performers, confined specifically to the left hand Middle and Ring fingers.

Table-05 Distribution of dermatoglyphic Patterns in Average scored students-Right hand

DIGITS	MALE (A/W/L)	FEMALE (A/W/L)	X^2 VALUE	P-VALUE	REMARK
THUMB	1/20/13	5/13/15	4.280	0.118	NS
INDEX	4/14/16	6/21/6	6.332	0.042	S
MIDDLE	4/12/18	5/14/14	0.750	0.687	NS
RING	1/24/9	4/16/13	4.113	0.128	NS
LITTLE	1/14/19	4/9/20	2.898	0.235	NS

Interpretation-In average scored students, a statistically significant association between gender and fingerprint pattern type was found at the Index finger of the right hand (X^2=6.332,p=0.042) while thumb, middle, Ring, and Little showed insignificancy. It is noteworthy that the Thumb finger approached borderline significance (p=0.118), with females showing more Arches than males.

Table-06 Distribution of dermatoglyphic Patterns in Average scored students-Left hand

DIGITS	MALE (A/W/L)	FEMALE (A/W/L)	X^2 VALUE	P-VALUE	REMARK
THUMB	2/14/18	4/17/12	2.143	0.343	NS
INDEX	10/17/7	11/11/11	2.207	0.331	NS
MIDDLE	4/12/18	5/10/18	0.278	0.870	NS
RING	0/21/13	2/22/9	2.736	0.254	NS
LITTLE	0/21/13	4/1/28	27.661	<0.001	HS

Interpretation-In average scored students, a highly significant association between gender and fingerprint pattern type was observed at the Little finger of the left hand (X^2=27.661, p<0.001). Analysis of the observed frequencies revealed a striking gender difference — males showed a predominance of Whorls while females showed a marked predominance of Loops at this digit, while the Thumb, Index, Middle, Ring fingers were statistically insignificant (p > 0.05) difference found in both genders.These results suggest that the left Little finger may be a particularly sensitive digit for detecting gender-based dermatoglyphic differences in average academic performers.

Table-7 Distribution of dermatoglyphic Patterns in Low scored students-Right hand

DIGITS	MALE (A/W/L)	FEMALE (A/W/L)	X^2 VALUE	P-VALUE	REMARK
THUMB	2/20/6	3/15/16	4.925	0.085	NS
INDEX	8/12/8	6/14/14	1.509	0.470	NS
MIDDLE	3/7/18	2/7/25	0.766	0.681	NS
RING	1/15/12	2/20/12	0.471	0.790	NS
LITTLE	2/12/14	3/14/17	0.064	0.968	HS

Interpretation-In low scored students, no statistically significant association was found between gender and fingerprint pattern type across all five digits of the right hand (p>0.05). The Thumb finger showed a borderline trend (X^2=4.925, p=0.085), with females showing relatively more Arches and Loops compared to males. The Little finger showed the least variation between genders (X^2=0.064, p=0.968), indicating almost identical pattern distribution between males and females at this digit.

Table-8 Distribution of dermatoglyphic Patterns in Low scored students-Left hand

DIGITS	MALE (A/W/L)	FEMALE (A/W/L)	X^2 VALUE	P-VALUE	REMARK
THUMB	1/15/12	1/17/16	0.116	0.943	NS

INDEX	4/15/9	6/18/10	0.146	0.929	NS
MIDDLE	5/7/16	6/12/16	0.833	0.659	NS
RING	1/16/11	5/17/12	2.180	0.336	NS
LITTLE	2/9/17	3/11/20	0.063	0.968	HS

Interpretation- In low scored students, no statistically significant association was observed between gender and fingerprint pattern type across all five digits of the left hand ($p>0.05$).Chi-square values were uniformly low across all digits, ranging from 0.063 to 2.180, indicating a very close match between observed and expected frequencies.This table shows themost uniform non-significant results of all six gender-wise tables, reinforcing that dermatoglyphic patterns do not differ meaningfully by gender in this academic subgroups.

DISCUSSION

The current study was performed on 150 MBBS students of 1st Year, Session of (2024-2025) to determine the association between dermatoglyphic patterns and academic performance, when analyzing the overall gender-based distribution of fingerprint patterns across all ten digits, loops were the most prevalent pattern in females, whereas males exhibited a greater frequency of whorls, especially in the left little finger of average-scoring students. This directional finding — with whorls prevalent in males and loops prevalent in females — aligns with the dermatoglyphic literature. Rastogi and Pillai (2010) studied 200 medical students (100 male and100 female) aged 18–25 years at Kasturba Medical College, Mangalore, India, and reported that females had a higher prevalence of loops and arches.

Whorls [18]. Bhavana D et al. (2013) indicated that the predominant pattern in males was whorls (57.09%), whereas in females, it was loops (52.63%)[19] . Amit A. Mehta and Anjulika

A. Mehta (2015) studied 140 first-year MBBS students at Indira Gandhi Government Medical College, Nagpur, comprising 70 males and 70 females, and observed that loops were the most prevalent while arches were the least prevalent in both genders [20].

The left little finger exhibited statistical significance ($p= 0.001$) in the entire comparison. In high-scoring pupils, the left middle finger ($p = 0.006$) and ring finger ($p = 0.002$) are also statistically significant. In pupils with average scores, the left little finger exhibited significant results ($p < 0.001$). The pupils with low scores generated the most consistent non-significant outcomes across all left-hand comparisons. The data indicate that the left hand exhibits greater sensitivity to gender-based dermatoglyphic variation than the right hand, suggesting a potential bilateral asymmetry in dermatoglyphic sexual dimorphism. This bilateral asymmetry is corroborated by Sangam, Krupadanam, and Anasuya (2011), who observed a significant bimanual disparity between males and females in Andhra Pradesh.

They found that whorls were less pronounced on the left hand, whereas arches and radial loops exhibited greater density on the left index finger, thereby affirming that the two hands do not exhibit identical gender-based pattern distributions [21]. Eze et al. (2020) conducted a study involving 200 medical students in Nigeria and observed that fingerprint patterns were more prevalent in the left hand compared to the right hand. In a gender-based analysis, females exhibited higher loop frequencies in the right hand, while males demonstrated higher whorl frequencies in the left hand. This discrepancy may result from differences in sample size or ethnic origin[22].

Loop were the most common pattern and tends to have higher scores on average than those with whorl/ arches. Also, Loops on both hands slightly associate with higher mean NEET scores. This suggests possible positive association between Loop pattern and bettter academic achievement. The present also revealed Arch patterns may be linked with lower NEET performance, though the sample size is small. Similar results reported by Adenowo and Dareb (2016) that distribution of Loop pattern was the highest among the category of high performer students and low percentage distributions of Arch patterns were higher in weak performer students [23]. Similarily observed by, Sachan et.al (2022) on 100 physiotherapy students (31 males and 69 females) of 3rd and 4th year of Teerthanker Mahaveer University, Moradabad, Uttar Pradesh [24].

Limitation:

The present study is a small scale study conducted within a single institute and did not compare the results with students from other institute.

CONCLUSIONS:

In the cross-sectional study of 150 undergraduate medical students, Loops were the predominant dermatoglyphic patterns overall, particularly among females, whereas male showed higher frequency of whorls, indicating a gender-based dimorohism in dermatoglyphic pattern distribution. The left little finger emerged as the most consistent site of significant gender difference across all academic performance categories($p<0.001$), with a slight predominance of whorls in the right hand and loops in the left hand, while arches remained the least frequent pattern. Digit-specific significant associations were additionally observed in the left- middle and ring fingers among high scored students and the right index finger among

average scored students, though these were not consistent across all groups.With respect to academic performance, loops were more commonly associated with higher scores, showing a slight positive relationship with better academic achievement, whereas whorls and arches were relatively more frequent in lower-performing groups. Arch patterns, in particular, appeared to be associated with lower performance, although the sample size for this pattern was limited.Overall, the study suggests that while dermatoglyphic patterns exhibit certain gender- and digit-specific variations, their association with academic performance is modest and not consistently significant, except for isolated findings. These results highlight the need for further large-scale studies to establish stronger and more reliable correlations.

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