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Original Article

# Sex Distinction in Digital Dermatoglyphic Patterns of Convicted Prisoners: A Comparative Cohort-Control Study

## التمييز بين الجنسين في الأنماط الرقمية لتَقَاطِيْعِ النِّهَايَاتِ الجلدية لدى السجناء المدانين: دراسة مقارنة بين الأتراب.

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## Abstract

The present study intends to analyse sex distinction in digital dermatoglyphic patterns in convicted prisoners and compare them with a normal control group.

For this purpose, a sample of 184 prisoners (149 males, 35 females) as well as 240 normal participants (male 120, female 120) were selected. The prisoner cohort group selected for the study was convicted for the following offences: Section 302 IPC, 307 IPC, 376IPC, 363-364 IPC, 366 IPC, 323-26 IPC. Galton's system of classification was followed to classify various dermatoglyphic patterns.

In the male criminal cohort group, the overall frequency of loop patterns (56.51%) was maximum compared to the frequency of whorls (38.79%) and arches (4.7%), while males in the control group exhibited the highest frequency of whorls (48.25%) followed by loops (47.67%) and arches (4.08%). In females, loops were the most frequently occurring pattern, whereas arches were the least frequently seen pattern in both the criminal and cohort group. The frequency of arches was lowest in both the hands with higher fractional percentage in the radial side (thumb and index finger) of distoproximal axis as compared to ulnar side (ring finger and little finger) in both the groups. Pattern intensity index (13.40 vs 13.05), and furuhata's index (69.35 vs 68.47) of the criminal males and females were found to be comparable, but the Dankmeijer's index (12.11 vs 18.93) of the male criminals was lower than their female counterparts, thereby indicating a higher occurrence of arches in the female criminal cohort group.

**Keywords:** *Forensic Science, Cohort Group, Dermatoglyphic Patterns, Prisoners.*

## المستخلص

تهدف هذه الدراسة إلى تحليل التمييز بين الجنسين في الأنماط الرقمية لتَقَاطِيْعِ النِّهَايَاتِ الجلدية dermatoglyphic لدى السجناء المدانين ومقارنتها مع المجموعة الضابطة السليمة.

لهذا الغرض تم اختيار عينة من ١٨٤ سجينًا (١٤٩ ذكور و ٣٥ إناث) بالإضافة إلى ٢٤٠ مجموعة مراقبة طبيعية (ذكور ١٢٠ ، إناث ١٢٠). أدين فريق مجموعة السجناء المختارين للدراسة في الجرائم التالية،: القسم 302 IPC ، 307 IPC ، 376IPC ، 364-363 IPC ، 366 IPC ، 323-26 IPC. وتم اتباع نظام تصنيف غالتون لتصنيف مختلف أنماط الجلد.

في مجموعة الأتراب المدانة جنائياً كان التواجد الكلي لنمط الحلقة لدى الذكور يساوي M = ٥٦ ٪، ولدى الإناث يساوي F = ٥٧,٥٤ ٪ وهو الأعلى بين الأنماط، متبوعًا بنمط الدوامة وقد كان لدى الذكور يساوي M = ٣٨,٧ ٪ ، ولدى الإناث يساوي F = ٣٧,٧١ ٪ ، ونمط الأقواس في الذكور يساوي M = ٤,٧ ٪، وفي الإناث يساوي F = ٧,١٤ ٪، في كلا الجنسين، بينما في المجموعة الضابطة كان نمط الدوامة هو النمط الأكثر شيوعًا في الذكور. وكشفت المقارنة بطريقة الأرقام أن الدوامة كانت أكثر تواتراً عند الذكور المجرمين، في حين كانت الحلقات أكثر انتشارًا في المجموعة الضابطة في كلتا اليدين باستثناء الرقم في الخانة الأولى من اليد اليمنى. تم العثور على مؤشر شدة الأنماط (٢٢,٦٩ مقابل ١٠,٦٩)، ومؤشر فوروهاتا (٥٦,٥٦ مقابل ٥٦,٧٢) من الذكور والإناث المجرمين لتكون قابلة للمقارنة، ولكن مؤشر Dankmeijer (١١,١٢ مقابل ١٨,٩٣) عند المجرمين الذكور كان أقل منه عند نظرائهم الإناث، ما يشير إلى ارتفاع حدوث الأقواس في مجموعة الأتراب الإناث.

**الكلمات المفتاحية:** علوم الأدلة الجنائية، مجموعة الأتراب، أنماط تَقَاطِيْعِ النِّهَايَاتِ الجلدية، السجناء

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## 1. Introduction

Dermatoglyphics is a collective term used for evaluating the epidermal ridges and patterns on the palms, soles, fingers and toes. Ridges are extremely narrow in infants and gradually broaden as the child grows, but exhibit no alterations in their original characteristics of branching, ending and other details [1]. The remarkable characteristics of permanence and uniqueness of fingerprints establish their scientific validity and enable the identification of individuals on the basis of their fingerprints in forensic laboratories across the globe. Fingerprints are also valid in a court of law, criminological research, the medical field, as well as genetic studies. Kohombange [2] made an attempt to identify criminal tendencies through analysis of handprints, with the objective of assessing the different abnormal features on the hand revealing criminal tendencies in people. In India, a criminal case in Bengal in 1898 was the first case in which fingerprint evidence was used to secure a conviction [3]. A study carried out by Malhotra et al. [4] suggested a strong association between crime and dermatoglyphic characteristics. They studied dermatoglyphic variations between four sex crimes and other crime convicts. Comparative account presented that persons who committed two closely related sex crimes, IPC-363 (kidnap) and IPC 366 (abducting), had significant distinctions in their dermatoglyphic characters. A comparison of friction ridges on fingertips between persons who committed sex crimes and other crimes presented minor differences with respect to crime under IPC-363 (kidnap) and IPC-363 A (kidnapping a minor for purpose of begging), as well as in IPC 366 (abducting), and IPC-366 A (procuration of minor girl).

An extensive and continually growing body of literature has explored differences in the distribution of dermatoglyphic patterns in various populations and ethnic groups [5,6,7,8,9,10,11,12], but the research dealing with sex distinctions of digital dermatoglyphic patterns of criminals is currently sparse. The present study may be a promising contribution in the field of criminological research in identifying criminals as well as the antisocial mentality of individuals by using digital dermatoglyphics. A study by Vogel and Motulsky [13] on monozygotic and dizygotic twins described that inclination to carry out a crime appears to be strongly genetically controlled. There is remarkable evidence that chromosomal abnormalities lead to appreciable differences in dermatoglyphic characters [14]. Hence, understanding this aspect of convicted prisoners will be important from anthropological, psychological and forensic perspectives, because very limited work [15, 4, 16, 17, 18 ] has so far been conducted in this sphere. Therefore, the present study has the following three objectives: (i) to assess sex distinctions in digital dermatoglyphic patterns among convicted prisoners, (ii) to compare dermatoglyphic patterns of a criminal cohort group with controls, and (iii) to analyse sex differences with respect to various dermatoglyphic indices.

## 2. Materials and Methods

The current control-cohort study consisted of a sample of 184 prisoners (males 149, females 35) and 240 controls (males 120, females 120) within the age range of 18-24 years. Ethical clearance for the study was obtained from the Institutional Ethics Committee, Panjab University, Chandigarh. Fingerprints of the male and female convicts were taken from the Kaithal Jail and Karnal Jail (Haryana, North India) with the required permission from the concerned authorities. The prisoners were convicted under section 302 IPC (murder and attempted murder), 307 IPC (attempt to commit murder), 376IPC (Rape), 363-364IPC (Kidnapping and abduction), 366 IPC (Aggravated forms of kidnapping and abduction), and 323-26 IPC (simple and grievous harm through blunt as well sharp weapons) were clustered in one group. A total of 240 subjects (120 males and 120 females) were randomly selected as a control group from different colleges in Nahan, in the Sirmaur district of Himachal Pradesh, North India. All the subjects from the control group did not have any previous criminal record. Prior to the commencement of the study, its purpose was explained to all the participants and their verbal consent was taken.

The inclusion criteria encompassed those subjects who were devoid of any scars, injuries or disease on the digits. All the patterns were classified into arches, loops and

whorls following Galton's system of classification [19]. The rolled fingerprints of all the participants were taken by following the simple inking method given by Cummins and Midlo [20]. The hands of the participants were thoroughly cleaned with soap and dried before taking prints to obtain complete patterns of the digits. A small dab of printer's ink (Kores India) was placed on the inking plate and spread as a thin even film with the inking pad and was evenly applied on the distal phalanges of each digit. All the fingers were properly rolled one by one on the sheet to obtain the complete pattern. While taking prints, any undue external pressure was avoided to prevent any smudging on the prints. Fingerprints were taken starting from the thumb (digit I), index finger (digit II), middle finger (digit III), ring finger (digit IV) and little finger (digit V) for both the right (R) as well as left (L) hand (Figure 1). For the right hand, digit I was denoted as R1, digit 2 as R2, digit 3 as R3 and so on. Similarly, the left hand digit I was designated as L1, digit 2 as L2, digit 3 as L3 and so on.

The following dermatoglyphic pattern indices were ascertained on each participant: Pattern intensity index = [(2 × whorl +loop) ÷N] [21, 22] , Dankmeijer's index = [(arches ÷ whorl) × 100 ] [23] , Furuhata's index = [(whorl ÷ loop) × 100][24]. Comparison of categorical variables was carried out by chi-squared test with a significance level of $p<0.05$.

## 3. Results

The frequency distributions of various types of digital dermatoglyphic patterns of the criminal and control groups in both sexes are summarized in Table-1. In males, the overall frequency of loop patterns (56.51%) was highest in the criminal group as compared to the frequency of whorls (38.79%) and arches (4.7%). Males in the control group presented the maximum frequency of whorls (48.25%) followed by loops (47.67%) and arches (4.08%). These differences were statistically significant, as is apparent from the chi-square test in both the control and cohort groups of males. In females, loops were the most frequently occurring pattern, whereas arches were the least frequently seen pattern in both the criminal and cohort group (Table 1). Results of the chi-square test exhibited non-significant differences in both the groups of females.

Digit wise frequency of dermatoglyphic pattern types among males from the criminal and cohort group is documented in Table-2. Digit wise frequency of dermatoglyphic patterns revealed that loops were more frequently occurring pattern in criminal males, whereas whorls were more prevalent in the control group in both the hands, except for digit I of the right hand where a reverse trend was noted. Digits on the radial side of the anatomical axis showed a higher prevalence of arches as compared to the ulnar side in both the sexes in the study and control groups. Prevalence of arches was higher in the right hand of the criminal group (except digit I and digit V), while the control group exhibited a higher frequency of arches in the left hand (ex-

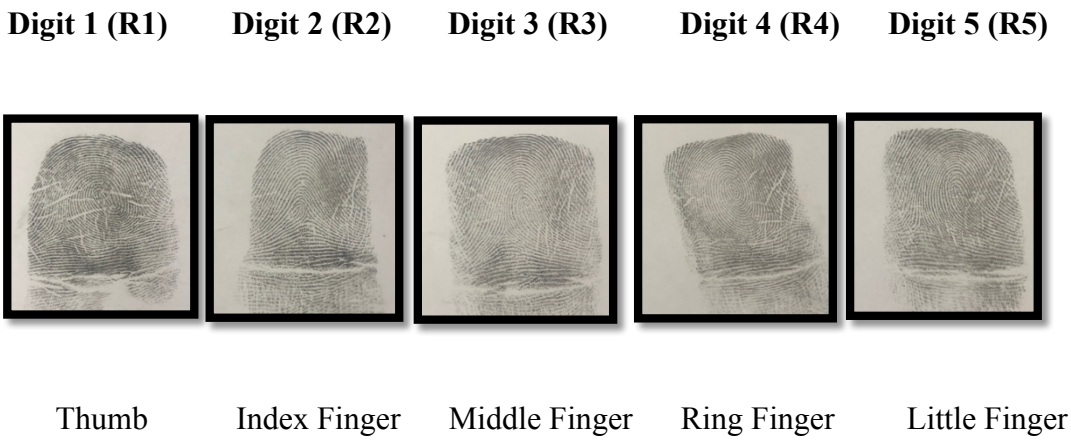


**Figure 1-** *Numbering of digits on right hand.*

**Table 1-** *Frequency distribution of various dermatoglyphic pattern of criminal and control groups.*

| | Males | | Females | |
|---|---|---|---|---|
| | Criminal n (%) | Controls n (%) | Criminal n (%) | Controls n (%) |
| **Arches** | 70(4.70%) | 49(4.08%) | 25(7.14%) | 79(6.58%) |
| **Loops** | 842(56.51%) | 572(47.67%) | 193(55.14%) | 657(54.75%) |
| **Whorls** | 578(38.79%) | 579(48.25%) | 132(37.71%) | 464(38.67%) |

*Chi square test males 24.28**, p > .05 ; Chi square test females 0.198, p < .05*

**Table 2-** *Digit wise frequency of dermatoglyphic pattern types among male criminal and control groups.*

| Pattern Types | | Arches | Loops | Whorls | Chi-square test |
|---|---|---|---|---|---|
| | **Digits** | **n (%)** | **n (%)** | **n (%)** | |
| **Digit I** | **Criminals R1** | 3(2.01%) | 48 (32.21%) | 98(65.77%) | 13.91* |
| | **Controls R1** | 1(0.83%) | 45 (37.5%) | 74 (61.67%) | |
| | **Criminals L1** | 4(2.68%) | 75 (50.33%) | 70 (46.98%) | |
| | **Controls L1** | 3 (2.5%) | 55 (45.83%) | 62 (51.67%) | |
| **Digit II** | **Criminals R2** | 19 (12.75%) | 74 (49.66%) | 56 (37.58%) | 7.83 |
| | **Controls R2** | 12 (10%) | 50 (41.67%) | 58 (48.33%) | |
| | **Criminals L2** | 18 (12.08%) | 77 (51.67%) | 54 (36.24%) | |
| | **Controls L2** | 15 (12.5%) | 47 (39.17%) | 58 (48.33%) | |
| **Digit III** | **Criminals R3** | 11 (7.38%) | 105 (70.46%) | 33 (22.14%) | 9.50 |
| | **Controls R3** | 5 (4.17%) | 72 (60%) | 43 (35.83%) | |
| | **Criminals L3** | 8 (5.37%) | 104 (69.79%) | 37 (24.83%) | |
| | **Controls L3** | 8 (6.67%) | 72 (60%) | 40 (33.33%) | |
| **Digit IV** | **Criminals R3** | 5 (3.35% ) | 52 (34.89%) | 92 (61.74%) | 13.29* |
| | **Controls R3** | 2(1.67%) | 32 (26.67%) | 86 (71.67%) | |
| | **Criminals L3** | 1 (0.67%) | 65 (43.62%) | 83 (55.70%) | |
| | **Controls L3** | 1 (0.83%) | 37 (30.83%) | 82 (68.33%) | |
| **Digit V** | **Criminals R5** | 0 (0%) | 114 (76.51%) | 35 (23.48%) | 18.11* |
| | **Controls R5** | 1 (0.83%) | 80 (66.67%) | 39 (32.5%) | |
| | **Criminals L5** | 1 (0.67% ) | 128 (85.90%) | 20 (13.42% ) | |
| | **Controls L5** | 1(0.83%) | 82 (68.33%) | 37 (30.83%) | |

**Table 3-** *Digit wise frequency of dermatoglyphic pattern types among female criminal and control groups.*

| Pattern Types | | Arches | Loops | Whorls | Chi-square test |
|---|---|---|---|---|---|
| | **Digits** | **n (%)** | **n (%)** | **n (%)** | |
| **Digit I** | **Criminals R1** | 2 (5.71% ) | 14 (40%) | 19 ( 54.28%) | 2.93 |
| | **Controls R1** | 5 (4.17%) | 60 (50%) | 55(45.83%) | |
| | **Criminals L1** | 1 (2.85%) | 19 (54.28%) | 15 ( 42.85%) | |
| | **Controls L1** | 6 (5%) | 51(42.5%) | 63(52.5%) | |
| **Digit II** | **Criminals R2** | 5 (14.28%) | 19 (54.28%) | 11 (31.42 %) | 2.92 |
| | **Controls R2** | 14 (11.67%) | 65 (54.17%) | 41(34.16%) | |
| | **Criminals L2** | 7 (20%) | 15 (42.85% ) | 13 ( 37.14% ) | |
| | **Controls L2** | 17 (14.17%) | 57 (47.5%) | 46(38.33%) | |
| **Digit III** | **Criminals R3** | 2 (5.71%) | 27 (77.14%) | 6 (17.14%) | 3.91 |
| | **Controls R3** | 10 (8.33%) | 84 (70%) | 26 (21.67%) | |
| | **Criminals L3** | 3 (8.57 %) | 22 (62.85%) | 10 (28.57%) | |
| | **Controls L3** | 14 (11.67%) | 75(62.5%) | 31(25.83%) | |
| **Digit IV** | **Criminals R3** | 2 (5.71% ) | 15 (42.85%) | 18 (51.42% ) | 5.06 |
| | **Controls R3** | 2(1.67%) | 50 (41.67%) | 68(56.67%) | |
| | **Criminals L3** | 3 (8.57%) | 14 (40%) | 18 (51.42%) | |
| | **Controls L3** | 5 (4.17%) | 43 (35.83%) | 72(60%) | |
| **Digit V** | **Criminals R5** | 0 (0%) | 24 (68.57%) | 11 (31.42%) | 5.98 |
| | **Controls R5** | 1 (0.83%) | 88 (73.33%) | 31(25.83%) | |
| | **Criminals L5** | 0 (0%) | 24 (68.57%) | 11 (31.42%) | |
| | **Controls L5** | 5 (4.17%) | 84 (70%) | 31(25.83%) | |

cept for digit IV). The frequency of loops was greater in the left hand in all digits as compared to the right hand, except for digit III of criminals and digit II of the control group where an opposite trend was witnessed. Males in both the groups of the present study demonstrated that the highest frequency of whorls was recorded in digit IV followed by digit I, digit II and digit III, whereas the lowest frequency was noted in digit V for both the dominant and non-dominant hands, except for the right hand of criminal males, showing some minor fluctuations. The prevalence of whorls was higher in the right hand compared to the left hand in both the groups of males in the study, except for digit III of the criminal group. The frequency of arches ranged between 0% and 12.75% in all the digits. The highest frequency of arches was observed on digit II (Right: 12.75%, left: 12.08%) and the lowest frequency on digit V (Right: 0%, L5: 0.67%). The chi-square test depicted significant differences for the digit I, digit IV and digit V only. In criminal males, bilateral differences for loops and arches were evident in terms of frequency of patterns, but the trend of increment is similar in both the right and left digits with a slight variation in digit IV and digit I.

**Table 4-** *Comparative account of dermatoglyphic indices of criminal and control groups in both sexes.*

| Dermatoglyphic indices | | Right Hand | Left Hand | Combined |
|---|---|---|---|---|
| **Males** | | | | |
| **Pattern Intensity Index** | **Criminals** | **13.70** | **13.11** | **13.40** |
| | Controls | 14.65 | 14.18 | 14.41 |
| **Dankmeijer's Index** | Criminals | 12.10 | 12.12 | 12.11 |
| | Controls | 7.0 | 10.03 | 8.46 |
| **Furuhata's Index** | Criminals | 79.90 | 58.80 | 69.35 |
| | Controls | 107.53 | 95.22 | 101.37 |
| **Females** | | | | |
| **Pattern Intensity Index** | **Criminals** | **13.08** | **13.02** | **13.05** |
| | Controls | 13.15 | 13.27 | 13.21 |
| **Dankmeijer's Index** | Criminals | 16.92 | 20.89 | 18.90 |
| | Controls | 14.47 | 19.34 | 17.02 |
| **Furuhata's Index** | Criminals | 65.66 | 71.28 | 68.47 |
| | Controls | 63.69 | 78.39 | 71.04 |

The frequency distribution of various types of digital dermatoglyphic patterns for females of the criminal and cohort groups is shown in Table-3. The frequency distribution of dermatoglyphic patterns shows that loops were the most frequently occurring pattern followed by whorls and arches in both the right and left hand of both the criminal and control groups of females. Females in both the groups showed a higher frequency of loops in the right hand compared to the left hand, except for digit I of the criminal cohort group. The frequency of the whorls in the criminal and control group revealed the same trend, with some minor fluctuations. In the right hand of the female criminal group, the decreasing order of digit wise frequency of whorls was as follows: digit I> digit IV> digit II= digit V> digit III. Whereas in the control group, the following digit wise decreasing order was recorded: digit IV> digit I> digit II> digit V> digit III. The left hands in the criminal and control groups demonstrated a similar digit wise trend of whorls: digit IV> digit I> digit II> digit V> digit III. Arches were the least frequently occurring pattern in both the hands, with a higher fractional percentage in the radial side of the distoproximal axis compared to the ulnar side in both the control and cohort groups. Digit II of the female criminal group showed the highest occurrence of arches, whereas in digit V arches were absent. Sexual dimorphism clearly demonstrated that arches were more frequent in female criminals than their male counterparts, except for R3 and L5 of males. Similarly, in the control group females had a higher frequency of arches than their male counterparts.

Three dermatoglyphic indices, i.e. pattern intensity index (P.I.I.), Dankmeijer's index (D.I.) and Furuhata's index (F.I.) gauged from finger pattern types are summarized in Table 4. Sex distinctions were clearly evident in dermatoglyphic indices with males exhibiting a higher combined mean value of pattern intensity index (13.40 vs 13.05) and furuhata index (69.35 vs 68.47), but lower combined mean values of Dankmeijer's index (12.11 vs 18.90) than their female counterparts. The combined mean value of pattern intensity index and furuhata index was more in the control group, whereas the criminal cohort group revealed a higher

mean value for Dankmeijer's index in both the sexes. In criminal males, the mean values of pattern intensity index and Furuhata index were higher in the right hand, and the mean value of Dankmeijer`s index was slightly higher in the left hand. In criminal females, the mean values of Furuhata's index and Dankmeijer`s index were higher in the left hand. Dankmeijer's index of males and females of convicted prisoners was higher than their control counterparts. The Furuhata index and pattern intensity index of controls was higher than convicted male and female prisoners. Comparative account with respect to gender displayed a higher Dankmeijer's index, but lower pattern intensity index and furuhata's index in females of both the study group as well as the control group.

## 4. Discussion

Dermatoglyphic patterns start to form between the fifth and sixth week of intrauterine life and are fully developed by the 21st week [25]. They remain unaltered throughout postnatal life and are unique to any individual [19]. In the present study, loops were the most frequently occurring pattern in the criminal males followed by whorls and arches. Whereas the control group of males documented the highest frequency of whorls followed by loops and arches. In agreement with the findings of the present study, Bugge and Poll [26] noticed among Danish and German sexual offenders that the prevalence of whorls were lower in criminals than their non-criminal counterparts. A plethora of previous qualitative studies on dermatoglyphics of various ethnic groups [5, 6, 27] demonstrated that whorls were the most common pattern followed by loops and arches in males. The convicted prisoners held in Sabarmati Jail were studied by Pandey and Vyas [18] to assess the frequency of fingerprint patterns, and their results were compared with the normal Gujarati population. The results revealed that convicted prisoners had significant bilateral differences. The percentage frequency of patterns was more in one finger and less in the other within the convicts, and the same was true for the controls. When the complete right and left hands of both the groups were taken into consideration, no significant difference was observed, i.e. the dermatoglyphic patterns were almost similar in proportion.

A comparative study was conducted by Agarwal et al. [17] on prisoners and a normal population in North India to observe their fingerprint patterns. They noticed that in both hands of the control group the frequency of whorls and arches was higher, while the frequency of loops was higher among prisoners. They further observed that in the control group the higher frequency of whorls was associated with positive psychological features. Whereas individuals with greater frequency of loops showed characteristics such as a possible lack of concentration, adaptable, versatile and emotionally responsive. In the present study, the frequency of loops was found to be highest in digit V for both the right and left hands in both the cohort and control groups. Dorjee et al. [8] observed that the frequency of ulnar loops was greatest on the 5th digit among Limboo males (64%). A similar trend has been witnessed in a range of previous studies in various normal populations [28,29].

In the present study, the frequency of arches was higher in the criminal males (4.7% vs 4.08%) and females (7.14% vs 6.58%) compared to their control counterparts. Arches were the least frequently occurring pattern in both the hands with a fractionally higher percentage in the radial side (digit I and digit II) of the distoproximal axis compared to the ulnar side (digit IV and digit V) in both the control and cohort groups. The highest occurrence was noted in digit II and the lowest in digit V. Maris [30] also noticed lower frequencies of arches in digit IV (2%) and V (1%) than on digit I (4%) and digit II (11%). Agarwal et al. [17] noted that individuals with greater frequencies of arches were designated as withdrawn, repressive, secretive when challenged, naturally suspicious and resentful of other achievements. While studying the dermatoglyphic characters on fingertips of Swedish sexual offenders and normal individuals, Gustavson et al. [16] did not document significant differences in dermatoglyphic patterns of common offenders and the normal population of Northern Europe. Thus, the cause of antisocial behaviour of this group may be due to environmental factors rather than biological influences on the development of the central nervous system.

To gain insight into the relationship between violent behavior and biological as well as psychiatric variables, Climent et al. [15] studied ninety-five women prisoners. They noticed that women prisoners had the highest frequency

of whorls followed by arches and the lowest frequency of ulnar and radial loops. Their comparison with the control group of British women, as reported by Holt [31], presented a two-fold higher frequency of arches, but the difference in the total finger ridge count was not significant. In accordance with these findings, the female prisoners of the present study revealed a higher frequency of arches than their control counterparts as well as the male control groups. A study conducted by Biswas [32] examined fingerprint patterns of juvenile convicts and observed no marked differences.

A higher value of Dankmeijer index was noticed as compared to criminal tribe studied by Sen [33] as well as criminals from different areas of Uttar Pradesh [34]. Newman [35] described that the pattern intensity index is one of the most important criteria for the evaluation of the biologically meaningful differences between population groups. In the present study, both the male and female criminal cohort groups exhibited higher Dankmeijer's index, but lower pattern intensity as well as Furuhata's index than non-criminal control counterparts.

One of the major limitations of this study that proposes a link between dermatoglyphic patterns and crime is its lack of investigation into the social and economic background of the participants of the cohort group. Wilson and Hernstein [36] pointed out that crime cannot be understood without taking into account individual predispositions and their biological roots. Despite these concerns, the present study will be of incalculable value in forensic investigations in understanding this aspect of convicted prisoners.

**Conflict of Interest**

Nill

**Source of funding**

Nill

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