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Fingerprint Ridge Density of Convicted Male and Female Prisoners: A Pilot Study

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Abstract. The present cross-sectional study is an attempt to compare fingerprint ridge density of convicted male and female prisoners. Ridge density was determined on 125 prisoners (77 males, 48 females) by diagonally counting numbers of ridges with in a defined area in radial region of the fingertip. Contrary to previous studies convicted male prisoners of present study showed higher ridge density than their female counterparts, although differences were not statistically significant except at digit V of right hand. This trend was further confirmed by probability of proportions, and likelihood ratio of digit V of convicted prisoners exhibiting ridge density of 17 or more was most likely to be of male origin and ridge density of 14 or less was most likely to be of female origin with divergent behaviour.

Keywords: Divergent behavior; Cohort group; Dermatoglyphics; Prisoners; Ridge density.

1. Introduction

Dermatoglyphic is the study of epidermal ridges and their different patterns on palmar and planter areas[1]. The study of qualitative as well as quantitative characteristics of the fingerprint science has tremendous contribution in criminal identification. Vucetich's pioneered the practical application of the fingerprint science by developing a classification system on fingerprints of criminals. The first homicide solved by employing fingerprint evidence was the Rojas murder case and Argentina was the first country across globe to base exclusively on dermatoglyphics as a means of individualization[2]. A study of Galera et al.[3] noticed that qualitative characteristics (pattern type, pattern intensity index) and ridge counts are more extensively studied features of dermatoglyphics. The determination of sex from fingerprint ridge density

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as initiated by Acree[4] has immense relevance in the fields of forensic science, criminological research and physical anthropology. He identified ridge breadth and ridge-to-ridge (furrow) distance as two important ingredients of ridge density. Thereafter, a plethora of studies[4-10] have established the sex differences with respect to fingerprint ridge density in different populations, but till date very limited work has been carried out to highlight this aspect on convicted criminals. In a recent study, while analysing an association and individualization of dermal digital ridge density of a male penal population Kaur and Sharma[11] demonstrated that prisoner male have ridge density less than 12 ridges and higher than 15 ridges.

Baker et al.[12], carried out genetic studies on twins and adoptees and recognised possible contribution of genetic factors in antisocial behaviour including various forms of aggression and criminality. They further emphasized on greater concordance for such behaviour in genetically related individuals than their unrelated counterparts dwelling in the same environmental setting. Past studies also showed that chromosomal aberrations also exhibited marked convergence in dermatoglyphic characters[13]. Genetic research on XYY sex chromosome carried out by Jarvik et al.[14], observed that males having this chromosomal aberrations were taller, less intelligent, more physically aggressive than their counterparts with normal sex chromosome.

So it is apparent that inclination to divergent behaviour and digital dermatoglyphic characteristics are genetically determined. Hence the aim of the current study is to gauge (i) fingerprint ridge density of convicted male and females prisoners (ii) comparison of criminal cohort group with their non-criminal counterparts. Present study will be an attempt to early detecting the vulnerable group so that required preventive measures can be taken.

2. Material and methods

The current cross-sectional study consisted of a sample of 77 male and 48 female convicted prisoners. Fingerprints of convicted prisoners were taken from the Kaithal and Karnal Jail of Haryana State (North India) after obtaining necessary permission from the concerned officials. The male and female prisoners were convicted in the following different offences i.e murder and attempt to murder, simple and grievous assault, offences against women (including rape and kidnapping), socio-economic offences, POSCO, miscellaneous offences.In India, women represent a inappreciable proportion of prison population, so the present study form a smaller sample size of female prisoners. All the digits of the convicted male and female prisoners were numbered starting from thumb, index finger, middle finger, ring finger and little finger for both the hands. The digits of right (R) and left (L) hand side were connoted as R1, R2, R3, R4, R5 and L1, L2, L3, L4, L5 respectively. Digits were denoted as RR (right radial) and LR (left radial) depending on the side of the digit. Fingerprint ridge density was determined by diagonally counting numbers of ridges with in a defined area (surface area of 25 mm^2) in radial region of the fingertip following the method described by Acree [4] (figure 1).

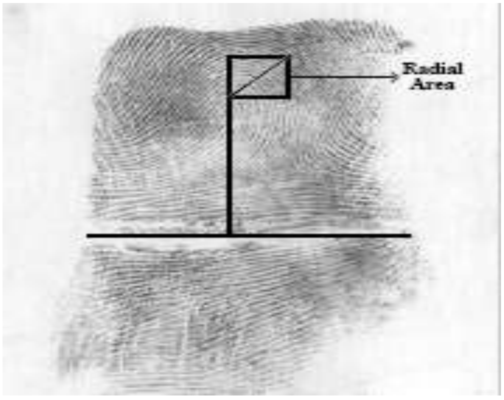

Figure 1. Illustration of radial area (25 mm^2) used to determine ridge density.

3. Statistical Analysis

Statistical Package for Social Sciences (SPSS) version 20 was employed to determine descriptive statistics including means and standard deviations for each digit on radial region. Bilateral differences in convicted male and female prisoners were calculated by the Wilcoxon Signed Rank test. The Mann Whitney U test was used to assess statistical significance of sex differences with a significance level of $p < 0.05$ was set for the test. Probability inferences based on ridge density values for males and females prisoners was determined by ascertaining a likelihood ratio (LR). This is indicated as probability of given fingerprint originating from male contributor (C)/ probability of given fingerprint originating from female (C').

4. Results

Mean and standard deviation of fingerprint ridge density in radial region of each digit among convicted males and females prisoners is presented in Table 1. The gradient of increasing ridge density in right hand was digit II < digit I< digit III < digit V < digit IV in both male and female convicted prisoners except some minor fluctuations. Fingerprint ridge density of left hand exhibited highest mean value in digit V and minimum in digit II. It is apparent from the Table 1 that convicted male presented higher ridge density than their female counterparts at most of the digits, but non-significant sex differences were noticed except at digit V of right hand. Bilateral differences were evaluated using Wilcoxon signed rank test in both the female and male prisoner group in Table 2. In radial region, males and females reflected significant bilateral differences at digit V only. Mean value of fingerprint ridge density was more on the digits of left hand than the corresponding digits of right hand in both the groups of convicted prisoners.

Table 1. Descriptive statistics and sex differences for fingerprint ridge density in radial region of each digit in convicted prisoners. Level of significance p < 0.05(*), p < 0.01(**).

Sex (N)	RR1	RR2	RR3	RR4	RR5	LR1	LR2	LR3	LR4	LR5
MALES (77)										
MEAN	14.35	14.06	14.78	15.47	15.18	14.74	14.22	15.10	15.39	15.81
S.D	2.47	2.03	2.20	2.32	2.01	2.39	1.99	2.45	2.49	2.15
FEMALES (48)										
MEAN	14.25	14.06	14.37	14.67	14.38	14.87	14.33	14.67	14.94	15.15
S.D	2.52	2.01	2.33	1.90	1.68	2.47	2.02	2.24	2.05	1.93
p-value	0.61	0.95	0.37	0.45	0.03*	0.61	0.80	0.34	0.32	0.09

Table 2. Wilcoxon signed rank test depicting bilateral differences between convicted male and female prisoners. RR: Right radial; LR: Left radial. Level of significance: p < 0.05(*), p < 0.01(**).

	Males	Females
Radial region		
RR1 vs. LR1	-1.38	-1.64
RR2 vs. LR2	-0.84	-1.00
RR3 vs. LR3	-0.85	-1.04
RR4 vs. LR4	-0.70	-0.82
RR5 vs. LR5	-2.26**	-2.59*

Distribution of digital ridge density (Table 3) was explained by probability of proportions, likelihood ratio and favored odds in convicted male and female prisoners at RR5 only, since statistically significant sex distinction was emerged only at this digit. Probability of proportions, likelihood ratio and favored odds of convicted prisoners on digit V demonstrated that ridge density of 17 ridges/25mm^2 or more was most likely to be of convicted male origin and ridge density of 14 ridges/25mm^2 or less was most likely to be of convicted female origin.

Table 3. Probability of proportions, likelihood ratio and favored odds of convicted male and female prisoners on digit V.

Ridge	FD		PD		LR		FO	
count	Males	Females	Males(C)	Females (C')	C/C'	C'/C	C	C'
9	-	1 (2.08%)	-	0.02	-	-	-	1
10	-	-	-	-	-	-	-	-
11	2 (2.59%)	1 (2.08%)	0.02	0.02	1.00	1.00	0.56	0.44
12	6 (7.79%)	5 (10.42%)	0.07	0.10	0.70	1.42	0.43	0.57
13	6 (7.79%)	5 (10.42%)	0.07	0.10	0.70	1.42	0.43	0.57
14	14 (18.18%)	15 (31.25%)	0.18	0.31	0.58	1.72	0.36	0.63
15	17 (22.07%)	7 (14.58%)	0.22	0.14	1.57	0.63	0.60	0.40
16	14 (11.18%)	10 (20.83%)	0.18	0.20	0.90	1.11	0.46	0.53
17	9 (11.68%)	3 (6.25%)	0.11	0.06	1.83	0.54	0.65	0.34
18	5 (6.49%)	1 (2.08%)	0.06	0.04	1.50	0.66	0.75	0.24
19	1 (1.29%)	- (-)	0.01	-	-	-	1.00	-
20	3 (3.89%)	- (-)	0.03	-	-	-	1.00	-

5. Discussion

Analysis of data in present study showed fingerprint ridge density of convicted male prisoner was higher at most of the digits than their female counterparts except at digit LR1 and digit LR2. Individual analysis of each digit employing Mann Whitney U test reflected statistically non-significant sex differences at all digits except at Digit V. The findings of a recent study conducted by Kaur and Sharma[11] demonstrated that convicted male prisoners had ridge density less than 12 ridges and higher than 15 ridges, i.e. placed on the two extremes. Results of present study was not in accordance with most of the previous studies carried out on different non-criminal populations[4,7-10,15-17] highlighting significant sex distinctions in the fingerprint ridge density with females having higher fingerprint ridge density as compared to their male counterparts. A study conducted by Oktem et al.[18], also observed a significantly higher fingerprint ridge density among Turkish young adult females than their male counterparts in radial area of a fingerprint. While analysing distribution and sex variation of the a–b ridge count, David[19] perused total ridge count may be influenced by double number of X chromosome in females, thereby confirming the contribution of genetic component of the individual especially by the sex chromosome. Interestingly despite of double dose of X chromosome in females, findings of current study exhibited a reverse trend. This trend was further supported by the probability of proportions, likelihood ratio and favored odds of convicted prisoners on digit V showing that ridge density of 17 or more was most likely to be of male origin and ridge density of 14 or less was most likely to be of female origin with divergent attitude. Fingerprint ridge density of digit V of the criminal cohort group of present study has been compared with similar available data from various other populations (Table 4). It is apparent from the Table 4 that convicted criminal males had higher and convicted females had lower ridge densities as compared to their non-criminal counterparts from other studies[20-22].This may be due to thicker digital dermal ridges of convicted criminal females and finer ridges of convicted criminal males, a trend opposite to the non-criminal population [4,10, 17,22].

Table 4. Comparison of fingerprint ridge density of digit V of cohort group of the present study with other populations. M=males; F= females.

Population	Sex	Fingerprint Ridge density Right Hand Mean (S.D)	Left hand Mean (S.D)	Reference
South Indian	M	12.93 (1.41)	12.79 (1.37)	Nithin et al., 2014
	F	14.94 (1.31)	15.27 (1.33)	
Sudanese	M	14.21 (1.28)	12.16 (1.30)	Ahmed and Osman, 2016
	F	16.35 (1.85)	14.06 (1.35)	
Uttarakhand	M	13.28 (1.59)	13.37 (1.69)	Yangchan, 2018
	F	15.24 (1.58)	15.26 (1.83)	
Criminal	M	15.18 (1.59)	15.81 (2.15)	Present study
	F	14.38 (1.68)	15.15 (1.93)	

With increasing the *misanthropical tendency* across the globe, there is a need for such studies to early identification of the persons vulnerable to divergent behaviour. To the best of my knowledge this is the only study carried out on the comparison of fingerprint ridge density of male and female convicted prisoner population. Limitation of the study is that the investigator was not allowed to interview the criminals individually to have in-depth information regarding their social, economic and psychological background. Although criminal behaviour is recognised after the occurrence of crime, but such studies might be utilized as “markers” in the screening methods for an advanced identification of the individuals risking a divergent behaviour. The observations of Vogel and Motulsky[23] on monozygotic and dizygotic twins described that propensity to commit crimes appears to be strongly genetically controlled. Hence the lower ridge density of female criminals than their male counterparts as divergence from their general trend suggests that female criminals may be having thicker ridges and criminal males have thinner ridges. Future in-depth research in this sphere is needed to substantiate these findings.

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