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DISTRIBUTION OF FINGERPRINT PATTERN ARCH IN RIGHT INDEX FINGER OF NATIVES (INHABITANTS) OF THREE GEOGRAPHICALLY DIFFERENT REGIONS OF INDIA

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ABSTRACT: *Since the advent of fingerprint science, researchers have been linking distribution of pattern types with human races. However, it was only after 1892, when Dr. Galton published his book - Finger Prints, where he categorised digital ridgeglyphics into Arch, Loop and Whorl, the fingerprint pattern classification came into prominence. In one of his studies, he calculated percentage frequency of arches in the Right Fore-finger of 2082 individuals belonging to four different races. In such studies of the past, and contemporary epochs, scientists have envisioned to segregate human races, or population groups on the basis of distribution of pattern types in the top phalanges of their fingers. The objective of this paper was to examine whether there existed any relationship between prevalence of rare pattern arch in Right Index finger, with nativeness / habitancy of Indians from three geographically different regions. The ten-digit fingerprint slips of 200 Indians from Himalayan Hill States, Plain (Flat) Lands, and Costal Regions, covering 18 States/Union Territories, were incorporated for the research. Unlike other fingerprint pattern types, emphasis was on pattern arch, which is rare, thus was included as a unique tag or marker for categorization of individuals for this ethnographic analysis. The study has once again proved that fingerprints are unique, and revealed no uniformity or commonality in occurrence of arches in the natives or inhabitants of a particular State/Union Territory (province) or the whole region.*

KEYWORDS : race, habitancy, nativeness, ten-digit fingerprint slip, patterns

INTRODUCTION

In fingerprint related ethnographical studies of the past and current periods, researchers have intended to categorise or slot human races, ethnicities, communities, natives of a region etc., on the basis of frequency of pattern types on one, more than one, or on all available fingers of hands. The broad objective of this paper is to examine whether there existed any relationship between prevalence of pattern types and natives/permanent residents/inhabitants of a region. In the backdrop of an established fact that every individual in this world has a unique and permanet set of fingerprints, this study may prove as an aid for comprehensive understanding of the previous efforts or studies by the scholars undertaken to link fingerprint patterns and human races, ethnicities, castes, communities, natives / ininhabitants etc. of a region.

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Probably, Dr. Henry Faulds, was the first scientist in modern history of dactyloscopy, who studied papillary ridges, of children of two races, the Japanese and the English, for nearly nine years until 1887, for variation in patterns (designs), and also observed permanency as a feature of fingerprints. But he studied the fingerprints of these two groups of children for analysing unique features, and had no intention to correlate them with their races. Apart from that he had also published an article in the *Nature*, October 28th, 1880 on the subject of fingerprints, titled- On the Skin-Furrows of Hand. **[1]** William J. Herschel too was involved in recording hand and finger marks since 1858, without realizing its importance in forensic identification, moreover, he has not been reported to have recorded fingerprints of individuals for racial categorization.

Dr. Francis Galton systematically studied the frequency of rare pattern arch in Right Fore-Finger (Right Index) on groups representing four races, the Jews, the English, the Welsh, and the African Blacks, and published his finding in his book-Fingerprints (1892). His findings are given under in Table-1:

Table-1: Frequency of Arches in the Right Fore-Finger (Right Index) [2]

No. of Persons	**Race***	**Number of Arches**	**Percentage**
250	English	34	13.6
250	Welsh	26	10.8
1332	Hebrew	105	7.9
250	Negro	27	11.3
Hebrews in detail			
500	Boys, Bell Lane School	35	7.0
400	Girls, Bell Lane School	34	8.0
220	Boys, Tavistock St. & Hanway St. School	18	8.2
212	Girls, Hanway St. School	18	8.5

* Names of the Races given in the above table are as used by Dr. Francis Galton in his Book Finger Prints (1892). Author has avoided, and at places even replaced names of races/words, used by him (or by others) with acceptable nomenclature in the contemporary times

The mid-twentieth century racial classification by American anthropologist Carleton S. Coon, divided humanity into five races: **[3]**

1. Negroid (Black) race
2. Australoid (Australian Aborigine and Papuan) race
3. Capoid (Bushmen/Hottentots) race
4. Mongoloid (Oriental/Amerindian) race
5. Caucasoid (White) race

Race and ethnicity are used to categorize certain sections of the population. In basic terms, race describes physical traits, and ethnicity refers to cultural identification. Race may also be identified as something you inherit while ethnicity is something you learn.**[4]** While in sociological studies, the community is defined, as a group who follow a social structure within a society (culture, norms, values, status). They may work together to organise social life within a particular place, or they may be bound by a sense of belonging sustained across time and space. **[5]**

Various attempts have been made, under the British Raj and since, to classify the population of India according to a racial typology. After independence, in pursuance of the government's policy to discourage distinctions between communities based on race, the 1951 Census of India did away with racial classifications. Today, the national Census of Independent India does not recognize any racial groups in India. **[6]**

As post-independence (Census, 1951) India, does not recognise any racial groups, thus in this paper, it will be found out whether there exited any corelation or link between a fingerprint pattern type and native-ness or permanent habitancy of individuals of a region/s having generally common topographic and climatic conditions. However, there have been many studies, after Independence, conducted by researchers / social scientists, involving Indian individuals of particular caste-groups, religion, ethnic communities, age-bands etc. Perhaps, to have better insight into the whole issue of correlation between human groups, and fingerprint pattern types, it will be appropriate to compare the results of some of the most relevant of those analyses, with the findings of this study.

OBJECTIVE

To ascertain whether there is any firm correlation between percentage frequency or distribution of rare fingerprint pattern arch in right index finger and native-ness or permanent habitancy of persons in three regions of India with different topographic and climatic conditions.

METHODOLOGY

Data & Data Collection

The Central Finger Print Bureau (CFPB) of the National Crime Records Bureau (NCRB), New Delhi, India which India's national repository of fingerprint slips, receives two types of 10-digit finger print slips; the slips for record, and the slips for search, from the States (Provinces) and the Union Territories of the country. The Record slips, carry personal (demographic) and conviction details, along with finger impressions (rolled and plain) of all 10-digits of hands, while the Search slips possess impressions, demographic details, and information about crime, but no details of conviction/sentence. While preparation of 10-digit fingerprint slips, the permanent address (native place) mentined by the convict or the accused, is checked/verifed by the Court/Police officer, with the Government (issed) documents like Adhaar Card (Unique Identity), Ration Card, Bank Passbook, Voter's ID card, Passport, or other similar authentic papers. Thus, the permanent address given on the fingerprint slip is an authentic proof of a persons native place/permanent residency/place of habitation.

Many a times the States/Union Territires (UTs) send more than the required copies of the fingerprint slips to the CFPB, and at the Bureau, such slips are marked *SPARE* and kept aside (in the trays or bunched together as bundles) for shredding/discarding. They are also used for imparting training & preparing training material. Two hundred such *SPARE* slips were picked-up randomly, they included both 10-digit Fingerprint slips for Record, and 10-digit slips for Search. Damaged/torn, slips with incomplete demograhic information, missing finger impressions (rolled & plain) etc., were not included for the study. Data collection, and compilation was done from August 2018 to November 2018 (four months).

Representation of States/Union Territories

The 18 States/Union Territories were represented in the study through the Ten-digit fingerprint slips received at the Central Finger Print Bureau, of the National Crime Records Bureau, New Delhi, in the form of slips for Record and for Search. The names (with two letter codes) of 18 States/Union Territories of India, included in the study are as under:

1.Assam (AS), 2. Meghalaya (ML), 3. Himachal Pradesh (HP**)**, 4 Chandigarh (CH), 5. Chhattisgarh (CT), 6. Delhi (DL), 7. Haryana (HR), 8. Madhya Pradesh (MP), 9. Punjab (PB), 10. Uttar Pradesh (UP), 11. Rajasthan (RJ), 12. Goa (GA), 13. Gujarat (GJ), 14. Karnataka (KA), 15. Maharashtra (MH), 16. Orissa (OR), 17. Tamil Nadu (TN), 18. West Bengal (WB)

Operational Definitions

1) Anthropology: Study of humans, both physical and cultural aspects.
2) Arch (Fingerprint) Pattern: In Arches the ridges run from one side to the other, making no backward turn, they are found in two types, the plain, and the tented.
3) Ethnicity and Race: In basic terms, race describes physical traits, and ethnicity refers to cultural identification. **[4]**
4) Community: In sociology, we define community as a group who follow a social structure within a society (culture, norms, values, status). They may work together to organise social life within a particular place, or they may be bound by a sense of belonging sustained across time and space. **[5]**
5) Habitancy: the state of living in a particular place at a particular time. **[7]** Habitancy in this study includes nativeness or permanent residency / habitancy / inhabitance of individuals in a region. It should not be confused with natives or aboriginal persons of a region. Whomsoever permanently stayed in a province or region has been considered as native (inhabitant) for this research.
6) Ethnography: the study and systematic recording of human cultures, also, a descriptive work produced from such research. **[8]**
7) Caste: According to the Oxford English Dictionary, the term caste is derived from the Portuguese casta, meaning "race, lineage, breed" and, originally, "'pure or unmixed (stock or breed)". **[9]**
8) Nativeness: The quality of belonging to or being connected with a certain place or reg ion by virtue of birth or origin. **[10]** The word native has been used in this paper for depicting permanent residents/inhabitants/habitants of a State/UT/region, and not as a synonym for aboriginal population.
9) Patterns: The designs or contours, formed by the friction ridges on the top phalange of fingers.
10) Ten-digit Fingerprint Slip or Card: The form having rolled and plain impressions of all 10-fingers (available fingers of hands), taken in a proper sequence.

METHOD

In this study, 200 ten-digit finger print slips of individuals, from a total of 18 States (Provinces) and Union Territories (UTs) of India, received at the Central Finger Print Bureau, New Delhi, for Record or Search, were scrutinised to find out rare fingerprint pattern type Arch, in Right Index (RI) finger of 200 individuals. Initially the slips from eighteen States/UTs, were sorted into three categories or regions, depending upon topographic and environmental conditions (geography) of the place, they had arrived from, which were:

1. Himalayan Hill States/Union Territories
2. States/ Union Territories with mainly Plain (Flat) Lands
3. Costal States/ Union Territories

Then, the States/UTs falling in each of the three regions, were counted and clubbed together, to form a table (Table-2). There were three States/UTs in Category of Himalayan Hill States/UTs, while eight became part of States/UTs with mainly Plain (Flat) Lands, similarly seven comprised the third category of Costal States/UTs.

Table-2: Names of States/UTs belonging to three different regional categories (for this study only)

S. No.	Category of the States/UTs	No. of States/UTs in the Category	Names of States/ Union Territories
1	Himalayan Hill States/UTs	03	Assam (AS), Meghalaya (ML), Himachal Pradesh (HP**)**
2	States/UT's with Mainly Plain (Flat) Lands	08	Chandigarh (CH), Chhattisgarh (CT), Delhi (DL), Haryana (HR), Madhya Pradesh (MP), Punjab (PB), Uttar Pradesh (UP), Rajasthan (RJ)
3	Costal States/UTs	07	Goa (GA), Gujarat (GJ), Karnataka (KA), Maharashtra (MH), Orissa (OR), Tamil Nadu (TN), West Bengal (WB)

After formation of of three regional categories (for this study) of representating States/UTs, 10-digit fingerprint slips from each of the State/UTs were scrutinized for the rare pattern arch in Right Index (RI), and other fingers of both the hands. The findings or the results were tabulated, mentioning total number of slips, total number of prints, number of Right Index (RI) fingers carrying pattern arch, percentage of arches against total number of slips, and percentage of arches against total number of fingerprints. As mentioned earlier, the rare pattern arch in Right Index (RI) fingers, was taken into consideration for this research, and as the number of female slips, during initial sorting of 200 eligible SPARE slips, was found to be negligible, thus fingerprint slips of only male subjects were included in this study. Although the number of arches in other fingers of hands was also recorded/tabulated, but the presence of arch in the Right Index (RI) finger of the subjects was the main point of interest, perhaps to make the study more explicit. Unlike earlier (19th and the 20th century), when use of thumb impression on documents was more popular, these days Index Finger of the dominant hand is used far more often in modern finger biometric devices, for excess control, verification of identitiy etc, that is one of the prime reasons for choosing RI finger for study. Moreover, recording a quality

impression from the index finger with ink or using a biometric fingerprint scanner, is physically more convienent for persons of all age groups than any other finger of the hand.

Here, eligible slips mean, slips complete in all aspects, i.e., slips carrying all 10 decipherable fingerprints prints (both rolled and plain), complete demographic information, especially details of permanent / native address, proof of authentication/verification (signature, stamp etc.) from the Court of Law/Police etc.

The tabulated results can be seen in Results and Discussion section.

RESULTS / FINDINGS

The Ten-digit slips from each State/UT were individually examined to identify the pattern in the Right Index (RI) finger, the information was then compiled, and accordingly placed under the three broad categories (of the States/UTs), as given in the table below (Table-3):

Table-3: States/Union Territories and % frequency of Arches in Right Index (RI) finger of Individuals/Persons

	Himalayan Hill States/Union Territories					
S. No.	State/Union Territory of the Native/Habitant	No. of 10-print F.P. slips from State/UT	Total No. of Fingerprints from State/UT	No. of Arches in Right Index (RI) Fingers	% of Arches on RI finger, in Total No. of Fingerprint slips from the State/UT	% of Arches in Total No. of Fingerprints from the State/UT
1	Assam (AS)-State	16	160	01	6.25	0.62
2	Meghalaya (ML)-State	21	210	Nil	00/00	0.00
3	Himachal Pradesh (HP)-State	11	110	02	18.18	1.81
	Total	**48**	**480**	**03**	**6.25**	**0.62**
States/ Union Territories with Mainly Plain (Flat) Lands						
4	Chandigarh (CH)-UT	01	10	Nil	00/00	0.00
5	Chhattisgarh (CT)-State	04	40	Nil	00/00	0.00
6	Delhi (DL)-UT/Capital of India	05	50	Nil	00/00	0.00
7	Haryana (HR)-State	01	10	Nil	00/00	0.00
8	Madhya Pradesh (MP)-State	03	30	01	33.33	3.33
9	Punjab (PB)-State	04	40	Nil	00/00	0.00
10	Uttar Pradesh (UP)-State	05	50	Nil	00/00	0.00
11	Rajasthan (RJ)-State	99	990	16	16.10	1.61
	Total	**122**	**1220**	**17**	**13.93**	**1.39**
Costal States/UTs						
12	Goa (GA)-State	03	30	1	33.33	3.33
13	Gujarat (GJ)-State	01	10	Nil	00/00	0.00

14	Karnataka (KA)-State	01	10	Nil	00/00	0.00
15	Maharashtra (MH)-State	02	20	Nil	00/00	0.00
16	Orissa (OR)-State	12	120	Nil	00/00	0.00
17	Tamil Nadu (TN)-State	10	100	Nil	00/00	0.00
18	West Bengal (WB)-State	01	10	Nil	00/00	0.00
	Total	**30**	**300**	**01**	**3.33**	**0.33**

Himalayan Hill States/UTs

Under the Himalayan Hill States/UTs category, we had three States, Assam (AS), Meghalaya (ML) and Himachal Pradesh (HP), with 16, 21, and 11, Ten-digit fingerprint slips each, respectively. In 16 slips or 160 fingerprints from Assam (AS), there was only 01 arch in RI finger, implying that the percentage frequency of arches in RI of 16 individuals was 6.25%, or it was only 0.62 % in 160 individual finger prints. The State of Meghalaya (ML), represented by 21 individuals or 21 Ten-digit fingerprint slips, surprisingly did not have even one case of prevalence of arch in Right Index (RI) finger (0.00%). The third State, part of the category of Himalayan Hill States/UTs, Himachal Pradesh (HP) was represented by 11 individuals or 11 Ten-digit fingerprint slips, had 02 cases of arches in RI finger, with percentage frequency rate of 18.18% in 11 persons or 1.81 % in 110 individual fingerprints (of the eleven individuals). There results from region with similar topographical and climatic conditions did not have identical or even similar percentage prevalence rate of arches in the chosen finger (RI).

Most astonishing part was that the state of Meghalaya which was formed by carving out two districts from the State of Assam; the United Khasi Hills & Jaintia Hills, and the Garo Hills on 21 January 1972. **[11],** too did not have any similarity in pattern distribution with Assam, there was not even one arch pattern in RI fingers of 21 individuals or 210 prints representing the State of Meghalaya.

States/ Union Territories with Mainly Plain (Flat) Lands

Analysis of data from region with mainly Plain (Flat) Lands, represented (in this study) by eight States/Union Territories, revealed that Chandigarh (CH), Chhattisgarh (CT), Delhi (DL), Haryana (HR), Punjab (PB), and Uttar Pradesh, did not have even one slip with Arch pattern in Right Index finger. Madhya Pradesh with 03 slips or 30 individual prints has only one arch pattern in RI finger, making it 3.33% percent prevalence rate in a total of 30 prints. The State of Rajasthan (RJ) which had the highest number of 10-digit fingerprint slips, at 99 numbers, or 990 individual prints, carried 16 arch patterns in RI fingers of the 99 subjects or individuals. The percentage frequency of Arches in RI finger, from slips of Rajasthan state, was 13.93 or 1.39 in 990 individual prints. In case of 08 States/UTs with mainly plain (flat) lands, did not show any trend in prevalence of arches in RI fingers, in six (06) States/UTs it was 0.00%, while in case of State of Madhya Pradesh (MP) it was 3.33%, whereas, in case of the State of Rajasthan (RJ) the percentage frequency was only 1.39 (%). The State of Rajasthan has borders with five other States (provinces) of India, which are Gujarat, Madhya Pradesh, Uttar Pradesh, Haryana, and Punjab. Except Gujarat (Costal State), other four are in the same category of Plain (Flat) Lands, even than there is no similarity in distribution of dermatoglyphic pattern arch in Right Index (RI) finger, amongst the persons of these five states (Rajasthan included).

Costal States/Union Territories

The block or category (for this study), of Costal States/UTs included seven States of India, which were Goa (GA), Gujarat (GJ), Karnataka (KA), Maharashtra (MH), Orissa (OR), Tamil Nadu and West Bengal (WB). Out of the 07 States in this block or category, only Goa (GA) with three (03) Ten-digit fingerprint slips, carried one (01) arch in RI finger, and the percentage frequency calculated for one (01) arch in thirty (30) prints was 3.33%. Rest of the six States did not have even one arch in Right Index Finger, in twenty-seven (27) persons or 10-digit fingerprint slips or 270 individual prints. Maharashtra (MH) and Karnataka (KA) have common boarders with Goa (GA), but out of ten (10) fingerprints from Karnataka and twenty (20) fingerprints from Maharashtra (MH), there was no arch pattern in Right Index (RI) finger, whereas Goa (GA) has one RI finger with arch pattern, out of thirty (30) individual fingerprints. The total percentage frequency of arches in Right Index (RI) finger of 200 male persons/10-digit fingerprint slips,included for this study was 10.5%, or it was 1.05% in the total of 2000 prints (may please refer Table-4).

Table-4: Percentage Frequency of Arches in Total No. of Right Index (RI) Fingers of persons/10-digit Fingerprint from three categorised (for this study) regions

S. No.	Region/Category of the States/UTs	No. of 10-digit slips from the Region	Total No. of Prints from the Region	No. of Arches on Right Index (RI) Fingers	% of arches in RI finger in total no. individuals /10-digit slips from the region	% of arches in RI finger in total no. fingerprints from the region
1	Himalayan Hill States/UTs	48	480	03	6.25	0.62
2	States/UTs with Mainly Plain (Flat) Lands	122	1220	17	13.93	1.39
3	Coastal States/UTs	30	300	01	3.33	0.33
Total		**200**	**2000**	**21**	**10.5**	**1.05**

Alike, amonst the individual States/UTs of the categosied regions, there was no similarity in distribution of pattern arch in Right Index (RI) fingers amonst the average of total individuals from each of the three categories or regions. The percentage frequency of arches in RI fingers in total prints of all persons of Himalayan Hill States/UTs was 0.62%, while the States/UTs with mainly Plain (Flat) Lands had a rate of 1.39%, whereas, the Costal States/UTs, got least prevalence of pattern arch in RI fingers against total prints of its individuals, at 0.33% only. The percent frequency of Arches in all ten finger of the three categorised regions, was also calculated and tabulated, the findings are given in Table-5:

Table-5: Percentage Frequency of Pattern Arch in All Ten Fingers of Individuals from three categorised (for this study) regions

S.No.	Category of the States/UTs	No. of 10-digit F.P. Slips	Total No. of Prints	No. of Arches in Right Index (RI) Fingers	No. of Arches in other 09 Fingers	No. of Arches in all 10 Fingers	% of Arches in all 10-digits against total No. of Prints
1	Himalayan Hill States/UTs	48	480	03	12	15	3.12
2	States/UTs with Mainly Plain (Flat) Lands	122	1220	17	61	78	6.39
3	Coastal States/UTs	30	300	01	05	06	2.00

DISCUSSION

The comparison of percentage prevalence rates of arches in Right Index (RI) fingers of individuals of different States/UTs within the three (03) categorised regions (i.e., Hills, Plains, and Costal), or total individuals/10-digit fingerprint slips of the three (03) regions, there was no remarkable uniqueness or a common marker to put the studied population of State/UTs, or of the whole categorised regions in a single band, group, or category. In other words, there was no similarity in dermatoglyphics or distribution pattern arch in Right Index fingers (or in all ten fingers) of population (persons/individuals) of any two states of the same region, or all the individuals belonging to the entire (categorised) region.

Geography and Fingerprint Pattern Distibution

Does overall topographical, or climatic conditions, or the overall geography of place or region matter in digital dermatoglyphics or fingerprint pattern distribution or pattern formation in a community, race, or tribe? This perhaps would be another important question stirring the nerve cells or the minds of the readers. If we compare two States (provinces) of India, Himachal Pradesh (HP) with lowest temperature range, and Rajasthan (RJ) with highest temperature range, makes the variation in climatic conditions of two States (provinces) very huge. Himachal Pradesh can have minimum temperature of -1.5 degree celcius in January, and maximum of 25.3 degree celcius in June. **[12]** The average maximum temperature of Rajasthan is 33 degree C to 38 degree C, and the minimum is between 18 degree C and 20 degree C. **[13]** In western Rajasthan the temp may rise to 48 degree celcius, particularly in May and June. **[14]** The values of percentage frequency of Arches in RI fingers of the natives of these two states, which are hundreds of kms apart, are slightly more similar, than the values of fingerprint pattern distribution in the natives of state of Madhya Pradesh (MP) which adjoins Rajasthan (RJ) and has common geographical border. Percentag frequency of pattern arch in in RI fingers of nativs of Himachal Pradesh (HP) a Himalayan Hill State was 1.81%, while Rajasthan (RJ) with plain (flat) lands, had 1.61% prevalence. Madhya Pradesh (MP) having common boarder with Rajasthan (RJ), had huge difference in the prevalence rate of pattern arch in RI finger of its natives/inhabitants, at 3.30%. The values clearly demonstration that topographological and climatic conditions or the overall gepgraphy of a place may not have any or much of an impact in digital dermatoglyphics of the natives (ininhabitants) of a region.

Earlier Studies in India on Small Population Groups (i.e. Caste, Religion, Region etc.)

In the past, post-independence of India, many researches have been conducted by individuals or groups to find fingerprint traits in small population groups or individuals of particular Castes (i.e., Rajputs, Danguria-Tharu, Rarhi Brahmins, Dhimals, etc.), Regions of the Country (South Indians, Students from North-eastern part of India etc.), Religion (Muslims) etc., **[15] [16] [17] [18][19] [20] [21]**. Please refer the table given under for the important findings (Table-6):

Table-6: Percentage Frequency of Pattern Arch in All Ten Fingers of Males Humans from different Castes and Other Population Groups from India (conducted by other researchers)

S.No.	Population/Ethnic group	Number of Persons	Total No. of Prints of Persons	% Frequency of Arches in Total Prints of Persons	Study conducted by: Individual/Group
1	Rajput (Himachal Pradesh, India)	50	500	2.00	Singh and Garg **[15]**
2	Danguria Tharu of Uttar Pradesh, India)	379	3790	3.87	Srivastava **[16]**
3	Rarhi Brahmins (Bengal, India)	100	1000	2.3	Chattopadhyay et al. **[17]**
4	Dhimals of North Bengal (Bengal, India)	101	1010	2.75	Biswas **[18]**
5	South Indians (India)	250	2500	5.68	Nithin et al. **[19]**
6	Medical Students (Gangtok, Sikkim, India)	55	550	4.50	Kanchan et al. **[20]**
7	Muslims (Central India, India)	240	2400	3.50	Neeti et al. **[21]**

Such studies, involving analysis of dermatoglyphics of individuals of particular community, caste, tribe, religion, habitany (i.e. south Indians, North-east Indians etc.), would have been far more complete, had there been simultaneous analysis of different population groups/communities/castes/religions of an area/region/State/UT (instead of examining only one caste, religion or small population group/type of an area or region). In the analyses where only one population group/type is included, there would be no results/findings of other population groups/types of the same area, for comparison. In the absence of such comparative data, it would not be possible to examine whether individuals of different castes, clans, religions, communities etc. habituating in the same area/region/State/UT, had identical trait/s or different trait/s, in distribution of fingerprint patterns. For example, a study in any one district, of any one State/UT of India, involving at least 200 members each of 05 different castes (i.e. Brahmin, Rajput, one caste from scheduled caste communities, one caste from scheduled tribe communities, and one caste from Other Bacward Communities etc.), and/or individuals of five different religions (i.e. Hinduism, Islam, Sikhism, Christianity, Buddhism etc.), would have given a clearer picture whether dermatoglyphic pattern distribution is caste/religion specific, or it has no correlation with the caste/religion (or smaller population groups) of an area/region/State/UT.

Similar Studies in Nigeria and their Findings

In three different studies on digital dermatoglyphic pattern distribution conducted, by Ekanem et al. (2008), Enberg et al. (2011), and Eboh et al. (2012), **[22] [23] [24]** in different groups of Nigerians (all Black Africans) from different regions of the country; no commonality was found in the distribution of pattern arch in the fingers of subjects of the same race. On analysis of the results of three studies on male subjects, it was found that percentage prevalence of arch in total fingers of both hands, ranged from 0.47% in Ijaws of Delta State, Nigeria to 17.5% in Aniomas of Southern Nigeria. The difference between the prevelance of arches in Annang, Ijaws, and Urhobos appeared less, but it also ranged from 0.80 % to 2.1 %. (Pls. refer Table-7)

Table-7: Percentage frequency of arches in different population groups in Nigeria.

S.No.	Population/Ethnic group (MALES ONLY)	Number of Persons	Total No. of Prints	% Frequency of Arches in Total prints	Study conducted by: Individual/Group
1	Annang ethnic group (Nigeria)	200	2000	15.4	Ekanem et al. **[22]**
2	Ijaws (Delta State, Nigeria)	100	1000	0.47	Anibor et al. **[23]**
3	Aniomas (Southern Nigeria)	176	1760	17.5	Eboh **[24]**
	Urhobos (Southern Nigeria)	224	1010	16.7	

ANALYSIS OF RESULTS/FINDINGS

The findings of various studies in India, and other parts of the world, make it fairly evident that the distribution of digital dermatoglyphic patterns may not be dependent on caste, race, tribe, appearance, colour, religion, geography, etc., of human population groups, there is something more than the genes or genetics, which decides on the formation of distinctive peculiarites in dermatoglyphic patterns in humans. Most likely, it's the micro environment in the womb, which certainly cannot be 100% identical in case of two pregnant women, even if they are from same race, caste, tribe, religion, region etc. Furthermore, in case of monozygotic or identical twins (which have different digital friction ridge characteristics), it could be the side, position of the growing foetus, and/or sitting pattern or sleeping postures of the mother in initial months. A particular posture may lead to increased/decreased amniotic pressure on one of the foetuses, impacting hands, especially fingers, which could have a role in the formation of different dermatoglypic patterns or varied shapes of the minutiae. The recent findings in the field of genetics of dermatoglyphics also emphasies on the environment inside the womb.

The basic size, shape, and spacing of dermatoglyphs appear to be influenced by genetic factors. Studies suggest that multiple genes are involved, so the inheritance pattern is not straightforward. Genes that control the development of the various layers of skin, as well as the muscles, fat, and blood vessels underneath the skin, may all play a role in determining the pattern of ridges. The finer details of the patterns of skin ridges are influenced by other factors during fetal development, including the environment inside the womb. These developmental factors cause each person's dermatoglyphs to be different from everyone else's. Even identical

twins, who have the same DNA, have different fingerprints. Few genes involved in dermatoglyph formation have been identified. Rare diseases characterized by abnormal or absent dermatoglyphs provide some clues as to their genetic basis. For example, a condition known as adermatoglyphia is characterized by an absence of dermatoglyphs, sometimes with other abnormalities of the skin. Adermatoglyphia is caused by mutations in a gene called SMARCAD1. **[25]** The activity of the skin-specific isoform of the SMARCAD1 protein is likely one of several factors that determine each person's unique fingerprint pattern. **[26]** Although, it has not been confimd as yet, that the skin-specific isoform of the SMARCAD1, is critical in making a person's fingerprints unique, it may be one of the many known factors of high interest, still there would be many niches in the biology of digital dermatoglyphics which must have been left unexplored.

I have not come across any study in the last over 20 years of my career in the field of fingerprint science, where two population groups, consisting of same caste/s, same religions/s, same tribe/s, and same geographic or topographic region, having identical dermatoglyphic pattern distribution even amongst their own tribe (population group). There can be similariltes in digital dermatoglyphics amongst the progeny or parents and children, twins, but that too is not a norm. We all know that even monozygotic twins with identical DNA traits, do not possess identical ridge characteristic in relative positions, even if they have similar pattern types in their corresponding fingers. So, studying digital dermatoglyphics in only one or an isolated population group of an area, based on caste, race, religion, colour, etc., may not be a right approach to determine dynamics of digital dermatoglyphic pattern distribution.

Implication to Research and Practice

Since 19th century, many researches have been conducted by individuals or groups to find fingerprint traits in small or isolated population groups or individuals of particular community, race, caste, religion etc., which did not throw enough light on pattern distribution amongst intra or inter population groups of the region. In this study different subjects of a given area (State/UT/Region) were included, which assisted in better understanding of the dynamics of pattern distribution amongst population types, it became evident from the analysis of the results, that even individuals habitating in same topographical or climatic region/s differed in percent prevalence or frequency of pattern types.

CONCLUSION

It is clear from this study that there is no commonality in distribution of the rare pattern arch in Right Index (RI) fingers of natives (inhabitants) of a particular State/Union Territiry, or the Region (Hills, Plains or Costal) in which that State/UT is situated. The findings of this study re-authenticates that fingerprints of each individual are unique, and are not dependent on the place of habitation or geographical location.

Moreover, in the light of results of this study, it has also been inferred from the analyses of findings of previous studies by other individuals and groups, that determination of prevalence of digital drmatoglyphic pattern types in one population group (representing a particular caste, religion etc.) in isolation, without inclusion of other population groups (representing other castes, religions etc.) of the same area or region (for comparison of findings), may not lead to

firm conclusion on uniqueness of digital dermatoglyphic pattern distribution in persons of studied caste or religion.

FUTURE RESEARCH

Large scale studies may be conducted on different population groups (involving castes, reglions, tribes, etc.) of the same area, state/province or region, to have better understanding of the corelation between fingerprint pattern distibutions in individuals amongst intra and inter population groups.

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