A COMPARATIVE STUDY ON THE CORRELATION OF SEX AND AGE OF INDIVIDUAL WITH THE RIDGE DENSITY AND RIDGE WIDTH OF FINGERPRINTS AMONG GUJARATI POPULATION

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Abstract

Fingerprints are one of the most conventional techniques in criminal identification. It is useful as a valuable tool to establish the absolute identity of an individual[1] .Though it is a well established method for personal identification, there is much reliable information available in the form of primary characteristics of personal identification such as age, sex, stature. There is a possible existence of specific parameters in fingerprints to find out these characteristics[6,8,9].

In this study, an effort has been made to establish the correlation between the age and sex of an individual and the fingerprints. A total number of 100 samples of fingerprints is collected and analyzed. It was found that there is an increase in the width of ridges in fingerprints during childhood (from 6years) to adulthood (upto25 years) and then there is a reduction in the ridge width in middle age and again there is an increase in ridge width with the advancement in age. There is some fluctuation found to occur in the dimension of this parameter in the fingerprints.

An unambiguous microscopic examination of ridges in the fingerprints has been done to establish the possible correlation between sex of an individual and the ridge density. There is a distinct correlation has been established with the sex of individual with the ridge density. It was found that the ridge density is found to be greater among females than that of males. This is due to the size of ridges. Among females the ridges are finer than that of males. Though no discrete result has been established through this study for the estimation of age of an individual with the ridge dimensions of the fingerprints, there is a possible existence of correlation between ridge width and the age of an individual.

Key words: Fingerprints, ridge width, ridge density, child age, adult age, microscopic examination

Introduction

Fingerprints are considered to be most important, and the most reliable one for the identification of individuals[1,10,11]. This is the still being considered as a more reliable one in criminal identification, civil disputes and also for routine personal identification purposes[1,9,10]. Though this method is being conventional, it has got its important advantages such as non-duplicating method and is also considered to be unique[1, 10.11,13]

The personal identification as a whole involves primary and secondary characteristics. The primary characteristics include sex, age and stature. Though there is a possibility of positive and complete identification of individuals based on fingerprints, there are other important data

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available to explore from them as far as the primary characteristics are concerned. In this study an effort has been made to analyze the changes in the ridge dimensions of fingerprints with advancement of ages. There are some studies that been done are available on the changes in lipid levels according to the age of the donor of the print. [1]

In this study there is an effort made to find out the possible existence of correlation between the sex and age of an individual with the changes in the ridge dimensions of the fingerprints. In case of correlation of sex and the ridge dimensions, the parameter included was the ridge width. In case of correlation of age and ridge dimensions, the parameter included was the ridge density.

Materials and Methods

First of all consent has been obtained from the subjects after explaining about the prospects of the study with the strict adherence to the ethical issues. The subjects of the younger age groups of 6- 16 years of age were the school children.

The methodology followed was that prescribed by Cummins & Midlo.[2,3] The conventional method of Cummins & Midlo has been followed for the collection of fingerprint and palm prints in any study involving fingerprints. This is the easiest and the best fool proof method that has been followed by the researchers[5,8,9]. The rolled impressions have been taken from the children in plain white paper with dust free hands after being wiped with spirit. This needs simple tools such as the roller glass plate and printer's ink. In this method, a thin film of printer ink has been applied over a glass plate and the subject was asked to have the uniform application of the thin film of black ink over the fingertips using cotton pads. The subject would be asked to transfer the prints by moving the fingers from lateral to medial side. This has been transferred to fingerprint card which has ten squares spaces for individual fingers in addition to the plain white paper for the purpose of comparison and reference. Complete set of prints with impressions were thus collected. The patterns have been classified and tabulated. The results have been listed in tables according to their age and sex in separate set of tables and columns.

The parameters considered for the correlation of age and sex of the fingerprints is the ridge dimensions.[4,6,8,9,], As far as the age estimation is concerned the ridge width has been taken into study. For the determination of sex, ridge density has been considered.

As far as the analysis part is concerned, the use of research stereo microscope has been mandatory[6]. This is due to the magnification factors and the clarity of the ridges with finer details. The resolution of the ridges was found to be good with the possible readability up to the level of micrometers. The magnification of stereo microscope was kept at 10X for all the fingerprints with the uniformity have been followed for all the prints.

The width of ridges has been taken by following the standard method for calculating the way in each individual print. A particular pattern present in the thumb was being considered for analysis as a case of achieving uniformity. It could be either a whorl or a loop.

In each of the fingerprint pattern the 3rd and 4th ridges (from the core) have been studied[6,9]. It has been done from the lateral directions of whorl pattern or ulnar loop pattern that have been considered for the study. In the same way, to achieve symmetry, two other areas have been chosen on the other side of the pattern. This gives

the values of the actual dimension noted and could also probably minimize the errors.

This has been tabulated with the proper classification of the age and sex groups. This could be observed in the table shown below with the details of width of ridges (average of 3rd and 4th ridges from the core in different directions of the patterns).It was made certain that there is incidence of minimal errors in this observation.

(Picture shows the measurement of the ridge width and the calculation of the ridge density (red lines showing the points of reference)

Ridge Width

Ridge Density

Results and Discussion

The results that have been obtained from the observations were systematically classified and tabulated according to the age and sex of the subjects understudy. The following tables show the various dimensional changes of the ridges (ridge width) during the various .ages of life. (It may be possible to assess the influence of the dimensional changes in various ages and also the especially age and sex). The subjects have been grouped for an easy assessment and calculations[6]. The mean values of all these data have also been found out and have been presented.

By analyzing these results, it is possible to understand the existence of correlation between the ridge width of fingerprint and the age of an individual[4,6]

The age of an individual may have a possible influence in the epidermal ridge width[4,5,7]

These results do suggest the results of similar studies of David (1981) and Kralik.M and NovotnyV(2003). The variations of the ridge width is also found to be very much greater within the short period of age such as 5 and 15 years.[3,4,5,6]. There is a need of extensive study to be done bring out with more promising and reliable results.

From the above systematic observations of the findings, it may be possible to deduce that there is a possible association between the age of the individual and the ridge dimensions though there are no specific indication that the changes are linearly getting changed in accordance with the ages. Overall, the difference in the dimensions of the ridges (ridge width) is more inconsistent. There is an increase in the ridge width dimension from childhood (from the age of 6 years) and the same has been noted in this study. There after there is a decrease in the width in the adult ages (21-25) and again starts increasing rapidly during age of 45-50 years. The highest

values of the width would be possible to be distinctly noted during the age of 45-50 years .In a similar study[4] , there was an increase in the ridge dimension noted in the early and late childhood ages (from 5 to 15years). In this study, another informative result is obtained with the random changes of the dimensions of the ridges. This sort of fluctuation needs to be studied further to get more discrete results.

Ridge Density

For the purpose of the determination of the sex it would be more appropriate to determine the ridge density.[3,4,5,6,7,8,9] Ridge density may be expressed in terms of the numbers. This is the total number of ridges that are present in the given dimension. This can be noted according to the feasibility aspect of the researcher. In this case the ridge density has been found to be number of ridges present in the area of 500 m.

This parameter is useful for this specific data. The sex determination though is the relative aspect of the differences of the ridge densities which are found to be very minimal but still they are significant statistically. The following table shows the no. of ridges present in a linear area of 500μm. This is done by viewing the fingerprint pattern under the stereo microscope in the same magnification for all the subjects. The observations that have been noted are tabulated according to the sex and age for overall clarity. The ages those have been studied included 6years to 61 years. The authors have randomly collected these samples with the easy availability either from school children or from elders at home. In any case the studies showed the significant differences between the males and females as far as the ridge density are concerned. This is very much in concurrence with the studies done by other researchers in varied geographical conditions with different ethnic groups.[6,7,8]

Ridge Density among males and Females (area - 500μm)-Number of ridges present in the mentioned area)

Trait	Males	Females
Total	511	580
Average	9.29	10.54

Statistical Analysis

Chi-square Test:

$$\frac{(\text{Observed value}-\text{Expected value})^2}{\text{Expected value}}$$

$$=(580-511)^2/580$$

$$=(69)^2/580$$

$$=8.208$$

For Males: 511/55 = 9.29 For Females: 580/55= 10.54 Difference in the number of ridges between male and female = 1.25 P Values: 0.0042

Based on these observations, it is possible to establish the correlation between the sex of an individual and the ridge density of the fingerprints. In every observation, it is found that the width of the ridge is always greater among males than that of females[5,6,7,8,9] In other words the ridges are always thicker among males and finer among females. This can be done through the calculation of ridge densities. The differences between the ridge dimension values of male and females are lesser in terms of numbers while considering the area under study (of the ridges in patterns in terms of micrometers) still they are significant.

The results of this study are in concurrent with the previous studies[4,5,6,8,9]. A similar studies

have been done in the population groups of Punjab, Haryana and Rajasthan by some researchers in which the results were also found to have similar inferences[9] . Another study done by Sudesh Gungadin (2006) among the population groups of Karnataka which also presented the similar results[8].In the above mentioned study, the measurement of ridges were considered within an area of 25 square mm and the numbers found were found to be 13ridges per 25 mm^2 in males and 14 ridges among females. In this present study, measurement of ridge density was taken in an area 500 micro meters. It gives results with the near accuracy as that of the study done by Sudesh Gungadin. In the present study, there is a significant difference found in ridge density between male and female population. The main difference of the studies done by previous researchers and this present study lies in the population groups those were considered. The population groups those were considered for the study belonged to Karnataka, Punjab, Haryana and Rajasthan. In this present study, the population group considered was those of Gujarat. There is a need to consider about the possible influence of demography[9]. The results from this study population may have a significant influence in the outcome of the study. But this can be considered as a preliminary effort. More prospective results would be obtained with the inclusion of fingerprints from a greater population data with the varied population groups.

The values for the ridge density among males were found to be 9.29 but for the females it was 10.54. Though in the outlook it may be a smaller difference but while considering the ridge widths in terms of micro meters this is much a significant one. This was statistically found to be more significant with the p value of 0.004.

In any scientific research there has to be caution as the value represents the smaller population under study. So this outcome can be considered as result of preliminary study. This can be made use of by the future researchers to carry out further studies involving a larger population and the other consideration of the race, genetics and the physical status of the individuals. This might render some influence over the parameter. The ridge dimensions are significantly lesser than that of males. So it means the ridges are finer lines among females than males. In any case, the difference of ridge density in the given area is found to be more significant between males and females.

Conclusion

- There are significant differences in the ridge dimensions (ridge width) noted among the population groups in various ages in both males and females.
- There is also a significant difference between males and females in the ridge width in every age group.
- The ridge width of females in the all age group is found to be lesser than that of males in corresponding age groups.
- The width dimension was markedly lower among females when compared to the corresponding to the male in every age group taken under study.
- This study is a preliminary effort to establish the possible relationship between ages of the individuals with that of the ridge dimension.
- This study has imparted more scope on the possible correlation of sex of an individual and the fingerprints with reference to the ridge densities. There is a significant difference between the male

female ridge densities.

- The ridge density of the females is higher than that of the males because the ridge widths of the females are comparatively lesser. In other words females have finer ridges.
- This is the main reason for the existence of the difference in the ridge densities between the males and females.
- These results are the outcome of the analysis of the data collected within a considerably smaller population groups those belong to Gujarat alone.
- There is an obvious limitation of the study being the number of subjects taken for consideration. It may be possible to explore more accurate results with a more elaborate population groups being included in this aspect.
- These results are the preliminary outcome of study done on a specific and smaller group of population belonging to Gujarat.
- The correlation between the sex and the ridge dimension of fingerprints is more of a preliminary study; still this can be enhanced by including more number of data with various population groups.
- Though the correlation of the ages is possible to some extent, but still an extensive study may be necessary to get more precise results.
- Future researchers can throw more light in this aspect for more exploration of facts in this topic.
- The results are open for the future researchers to get more accuracy and enhance the scope.

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Table No.1

Range of Age (Years)	Male (ridge width in m)					
	Average among 1st group	Average among 2nd group	Average among 3rd group	Average among 4th group	Average among 5th group	Average (μm)
5-10	15.95	19.21	26.36	27.31	33.37	24.42
11-15	38.52	26.11	34.74	34.14	32.78	33.25
16-20	40.70	41.91	44.57	49.12	39.83	43.22
21-25	43.83	39.92	45.57	44.01	42.85	43.23
26-30	45.54	44.57	46.45	48.35	43.98	45.77
31-35	47.81	43.33	48.02	48.75	46.75	46.93
36-40	37.40	38.33	35.22	38.42	39.11	37.69
41-45	38.45	35.25	35.98	37.51	36.28	36.69
46-50	44.20	42.65	41.33	45.77	49.78	44.74
51-55	57.88	54.67	54.55	48.33	41.26	51.33

Table No.2

	Female (ridge width in m)					
Range of Age (Years)	Average among 1st group	Average among 2nd group	Average among 3rd group	Average among 4th group	Average among 5th group	Average (μm)
5-10	15.44	20.55	23.52	26.95	31.55	23.60
11-15	34.34	23.85	34.73	31.91	30.75	31.11
16-20	36.51	37.41	40.57	39.34	33.57	37.48
21-25	42.92	38.89	44.96	33.75	31.52	34.40
26-30	41.98	43.37	47.95	46.30	43.75	44.67
31-35	46.82	45.49	47.77	45.16	44.78	45.63
36-40	35.45	40.37	34.05	37.98	47.83	39.13
41-45	35.32	33.25	34.22	36.95	37.16	35.38
46-50	43.89	42.75	39.77	45.10	48.77	44.05
51-55	50.75	48.67	47.55	46.88	40.77	46.92