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Dermatoglyphics in Focus: Unraveling Fingerprint Pattern Relationships with Demographics, Genetics and Urban-Rural Variations in Medical Students of LUMHS, Jamshoro

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Abstract: **Background of the study:** Dermatoglyphics deals with the study of epidermal ridge patterns on fingers and palms that are formed during fetal life and remain unchanged throughout life. As these patterns are genetically determined, they are widely used in population studies, forensic identification and genetic research. **Aims of the study:** To evaluate the distribution of fingerprint patterns among undergraduate medical students and to assess their association with demographic factors, genetic background and urban–rural residence. **Methodology:** A cross-sectional analytical study was conducted from April 2025 to September 2025, among 500 MBBS students at Liaquat University of Medical and Health Sciences (LUMHS), Jamshoro. Fingerprints from all ten digits (5,000 fingerprints) were collected using the ink method and classified into loop, whorl, arch and composite patterns. Data were analyzed using SPSS v22 and results were expressed as frequencies and percentages. **Results:** Loop patterns were the most frequent (59.16%), followed by whorls (34.30%), arches (4.26%) and composite patterns (2.24%). The predominance of loop patterns was consistent across gender, age, ethnicity and area of residence, with only minor demographic variations observed. **Conclusion:** Loop fingerprint pattern is most frequent among medical students of LUMHS, showing strong genetic stability of dermatoglyphic traits. Demographic and urban/rural factors showed minimal effect, supporting the usefulness of dermatoglyphics as a non-invasive tool for population and genetic studies.

Keywords: Dermatoglyphics, Fingerprint patterns, Loop, Whorl, Arch, Area of residence, Demographic factors, Biometric identification.

INTRODUCTION

Fingerprint patterns are mainly formed by the growth of the ridges on the skin. This fingerprint pattern, which is particular to each individual, is permanently recorded in the dermis of our fingers, palms, toes and

soles during early fetal growth between 13 and 19 weeks of pregnancy [1-3]. The fingerprint pattern is an inherited characteristic, does not change remarkably after birth and is not influenced by environmental factors experienced after birth but is affected genetically. As a result, the field of dermatoglyphics (the study of fingerprints) has an accepted history of use as a tool in anthropology, forensic science, genetics and biomedical research [4].

The three major types of fingerprints are Loop, Whorl and Arch. Each has several subcategories as well. These variations have been associated with genetic inheritance, chromosomal aberrances and specific medical conditions [5,6]. Many researches have established associations between dermatoglyphic patterns and conditions/diseases such as diabetes or high blood pressure, schizophrenia, congenital heart diseases and Down syndrome, thus showing the usefulness of dermatoglyphics as a non-invasive screening/predictive tool.

In addition to physical characteristics such as age and sex, demographic factors such as gender and ethnicity also effect the distribution of fingerprints [7]. Moreover, most dermatoglyphic traits are ultimately due to the genes we inherit from our ancestors through family and genealogical research and fingerprint patterns in families tend to be similar. Environmental factors also play an indirect role in the distribution of fingerprints and methodology of demographic factors due to the effects of genetic pooling, population structure and lifestyle related to geographic differences [8-10].

Countries that have experienced rising interest in studies of their family histories; yet little is known about how much homogeneity there due to geographic regions across all members of particular families (individuals) who reside within these areas [11].

There is currently only little knowledge regarding the extent to which physical variations between countries affect individuals who do share common ancestry [12-14]; however, developing this understanding has remarkable implications for population profiling, genetic research and predicting future health risks among populations that effect these patterns.

This study is used to evaluate the relationships between dermatoglyphics and demographics, genetics and geographic location by examining the associations in these areas based on my student (MBBS) background in order to provide useful insight into both the physical characteristics of patterns and their relevance at the population level.

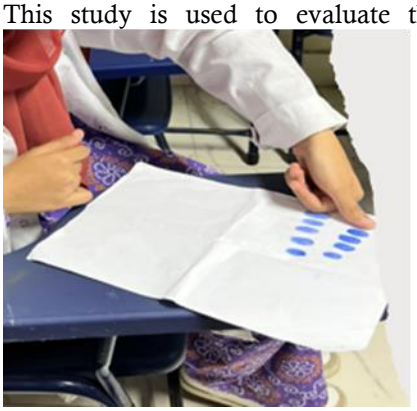
OBJECTIVES:

The main objective of the study is to establish a comprehensive analysis of dermatoglyphic fingerprint patterns in respect of their association with demographic factors, with regard to age, gender, occupation and ethnicity and to give baseline data for the future estimation of dermatoglyphic fingerprints as predictors of dermatoglyphics and ultimately produce future data for the purpose of genetic research/forensics.

METHODOLOGY:

A cross-sectional analytical study was conducted from April 2025 to September 2025, to evaluate the association between dermatoglyphics, demographic, urban/rural and genetic variables. The participants in this study were 500 MBBS students (Selected using a Non-Probability Convenience Sampling Method) who attended Liaquat University of Medical and Health Sciences in Jamshoro, Pakistan. Dermatoglyphics give a good indication of an individual's genetics. Participants (Male and Female) of all ages were eligible for this study who signed the informed consent form and did not have any abnormalities or damaged digits.

Data was collected by a structured questionnaire to collect the demographic characteristics of the participants. Data was collected on many variables i.e. Age, Sex, Ethnicity, Occupation and the area of residence (Urban vs. Rural). Data was taken on their family Background (ancestors) to reflect possible genetic Influences. Ten digits were collected for every participant using an Ink Method of collecting and taking fingerprints. After collection, the data was analyzed by applying the general guidelines for classifying fingerprints as per recognized dermatoglyphic classifications.



STATISTICAL ANALYSIS:

SPSS V22 was used to analyze information that was collected through MS Excel. Descriptive statistics were summarized for demographic data and distributions of fingerprint types. Comparative analyses of fingerprint types were performed to determine variations by gender and place of residence (urban/rural). Results of the analyses are presented using either graphical or tabular formats. A p-value < 0.05 was taken as statistical significance.

RESULTS

The results showed the dermatoglyphic patterns among 500 undergraduate medical students at Liaquat University of Medical and Health Sciences (LUMHS), Jamshoro. Five thousand (5,000) fingerprints were collected for this study. The majority of the participants in the study were aged between 18 to 20 years, followed by those aged between 21 to 23 years and between 24 to 26 years old. Males outnumbered females in the total sample (51.8%).

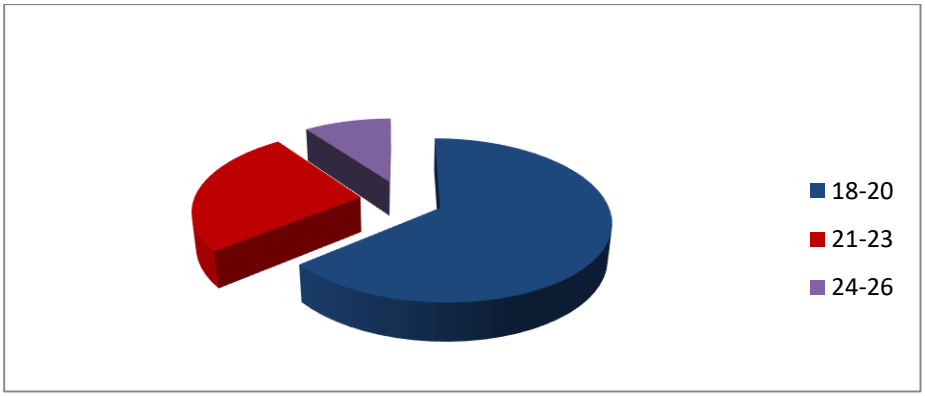


Figure-1: Showed the age wise distribution of the participants no intra-abdominal extension (Fig 2).

The sample has diverse ethnic representation of the overall medical student population among LUMHS, Jamshoro. Most of the participants had an urban background than rural Descriptive statistics were applied to summarize demographic variables and fingerprint pattern distribution.

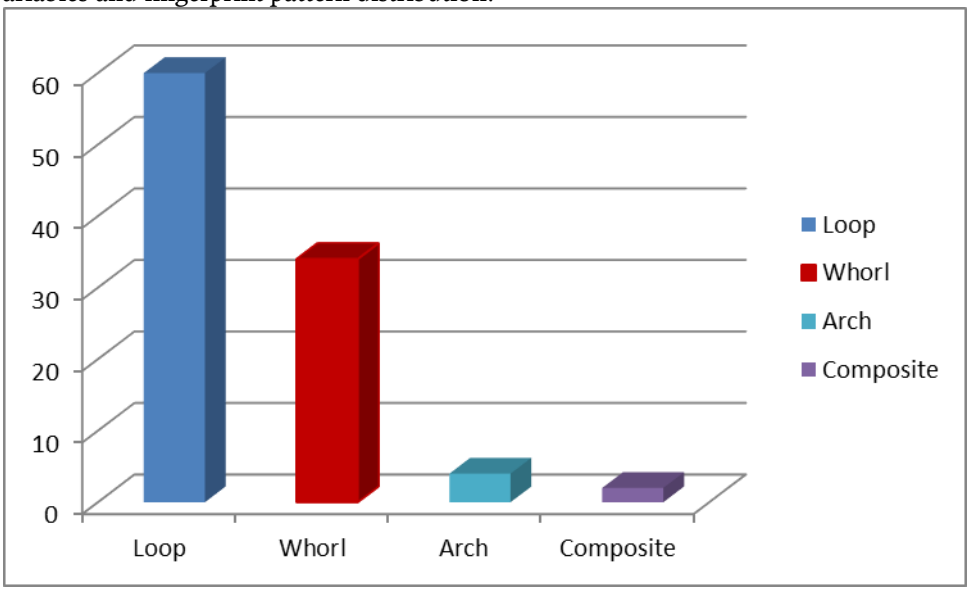


Figure-2: Showed the finger prints type of the participants

In this study, loop patterns of fingerprints occurred much more frequently than arch or composite patterns. The analysis of gender continued to show a very pronounced predominance of loop patterns in both men and women medical students although males had more frequency of whorl patterns as compared to females, who were again predominately looped. Touching on arch and composite patterns, there was very less difference between the two genders, indicating that gender have little effect on these two types of fingerprints.

As far as area of residence, loop patterning continued to be the most common type for both rural and urban youth. While urban students have little increase of whorl patterned fingers, the rural students showed a consequential

increase in arch or composite patterning. It indicates that area of residence has a limited effect on the fingerprint characteristics of the students obtained in this study.

Table-1: Showed the distribution of fingerprint patterns according to area of residence (n = 5,000 fingerprints)

Fingerprint Pattern	Urban Participants n (%)	Rural Participants n (%)	Overall Observation
Loop	Predominant	Predominant	Higher frequency in urban population
Whorl	Second most common	Second most common	More frequent in urban participants
Arch	Less frequent	Slightly higher	Marginally increased in rural population
Composite	Least common	Least common	Minimal variation between groups

Fingerprint patterns of different ethnic origins have the same predominant type of loops, regardless of ethnicity and the second most common pattern type of whorls, and the third type of arches and the fourth type of composites. The patterns for whorls and arches showed minor inter-ethnic variations. Moreover, the overall distribution of the dermatoglyphics remains the same; establishing that fingerprints are genetically determined by ethnicity and showed unique population characteristics.

DISCUSSION

The present study evaluated the distribution of dermatoglyphic fingerprint patterns and their link with demographic characteristics, genetic background and urban–rural residence. The findings showed a clear predominance of loop patterns, followed by whorls, while arches and composite patterns were least frequent. This overall distribution aligns with classical dermatoglyphic literature, which consistently reports loops as the most common fingerprint pattern among different populations worldwide [15,16]. Many researches have documented that loop patterns in approximately 60–70% of fingerprints, supporting the results of the current study [17-19].

Gender-wise analysis showed that loop patterns were the most common among both males and females, with whorl patterns occurring more frequently in males. Similar observations have been reported in another study conducted in South Asian and Middle Eastern populations, where males exhibited a higher tendency toward whorl patterns, reflecting sex-linked genetic influences on ridge formation [20]. On the other side, arches and composite patterns exhibited minimal gender variation, suggesting that these patterns may be less influenced by sex-related genetic factors.

In many researches, loops are the predominant type but whorls were found to be more frequent among urban participants, while arches were found to be slightly more frequent among rural participants [21,22]. Differences such as these have previously observed in previous research which evaluated that demographic structure, genetic mixing and marriage practices cause demographic distinctions between urban and rural caused more likelihood that specific genetic factors will influence variation in dermatoglyphic traits [23]. The influence that genetic background and ethnic background both showed differences in the frequency of different ethnic groups. Numerous previous studies have shown that families are clustered together having similar patterns indicating the low probability of random events causing clustering of families having similar dermatoglyphic patterns [24, 25]

These findings add to the body of evidence that fingerprint patterns are absolutely s related to both Demographic Factors and Genetic Factors but that there may also be secondary modifying Environmental Factors that influence such as Urban/Rural residence.

This study contributes additional information on a regional basis to the growing body of literature demonstrating that dermatoglyphics can be used as a non-invasive, inexpensive tool for Population studies and great addition to future Predictive Health Research.

CONCLUSION

This research demonstrated that dermatoglyphics can give an important biological marker of the demographic characteristics and genetic ancestry of human beings. The most frequently occurring fingerprints were loops; then whorls, arches and composites. In general, all groups had similar design and frequencies of the various types of fingerprints. Significant differences were showed in the relationship between fingerprints and gender, race and genetic background; this is due to strong genetic contribution to the patterns found on fingerprints. Small differences in frequency pattern between urban and rural populations showed that the effects of population structure and geographical residence are relatively small.

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