# Ethnic Variations in Fingerprint Patterns: A Texas A&M University Student Analysis

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**Abstract:** Due to the distinctiveness, reliability, and universality of fingerprints, they have become influential investigative tools in forensics. With the collection of genetic and environmental factors affecting each person's unique fingerprint, it is suggested that ethnicity is also an influence on fingerprint patterning. This study discusses the distribution of fingerprint patterns (loops, whorls, and arches) among four different ethnic groups: Hispanic, Black, Asian, and White, in a survey of 190 students at Texas A&M University. One hundred and ninety students were fingerprinted; the fingerprints were then analyzed for their fingerprint pattern and recorded. The data obtained from the percentage occurrence of fingerprint subtypes shows marked variations in the prevalence of patterns among the populations. Despite dissimilar frequencies, loops were found to be the predominant pattern across all groups. Whites showed the highest frequency of loops, 69.92%, while Asians had the least at 49.41%. While loops were less frequent in Asians, whorls were the most frequent compared to other ethnicities at 38.71%. Arches had the greatest variability of frequency, being most evident in the Black population and least common in Whites. The subtype analysis showed that radial loops and plain whorls were highly frequent in all groups while the tented arch and accidental whorl were uncommon. These findings indicated that there was ethnic variability in dermatoglyphic traits, which may be genetically and evolutionarily influenced. Future research could be conducted with a larger pool of participants to have a more accurate understanding of ethnicities in relation to fingerprint patterns.

*Keywords: Fingerprints, patterns, ethnicity, dermatoglyphic*

Since ancient Babylonian times, fingerprints have played a crucial role in identification. Instead of being used for business transactions, fingerprints today are imperative in biosecurity and serving as evidentiary support. Defined as an impression left by the friction ridges of a human finger, the distinctiveness, reliability, and universality of fingerprints are what make them such an influential investigative tool. Due to the unique patterns and ability to remain on surfaces, fingerprints have become a reliable form of identification in forensic science (Sahu and Rao 2025). Fingerprint analysts use three levels to describe fingerprints with each focusing on a different detail in the fingerprint makeup. Level 1 studies patterns such as loops, whorls, arches,

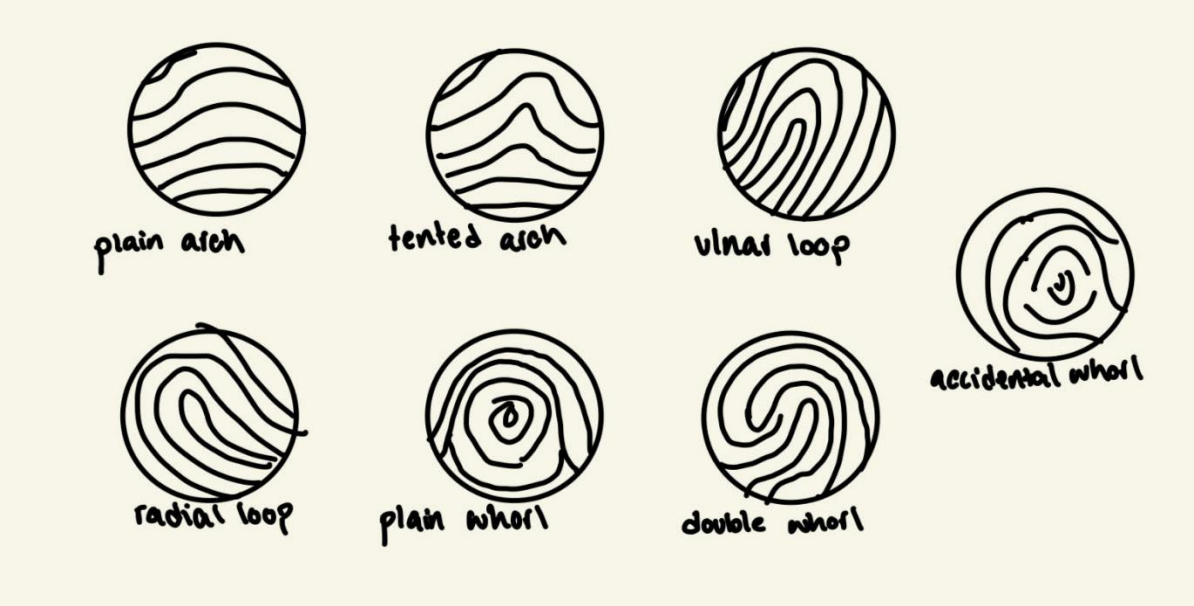


**Fig.1** Hand drawn fingerprint patterns.

and the number of ridges present (Fig. 1). Level 2 is used in criminal justice cases and focuses on bifurcations, or where the ridge splits. Level 3 goes down to the very pores on the fingers (Olufunso 2022).

Observational research has shown that fingerprint patterns formed during the first four months of gestation are most likely an inherited trait through (Bose and Kabir 2017, Olufunso 2022). The complexity of fingerprint patterns appears to be influenced by genetic and environmental factors, which is likely why each person's fingerprint is unique to them, including identical twins (U.S. National Library of Medicine 2022). Additionally, some studies have suggested that fingerprint patterns may be influenced by genetic factors such as those associated with ethnicity (Glover et al. 2022). For example, some research has indicated that African Americans tend to have more bifurcations than Europeans (Fessenden 2015). Research was done on students at Texas A&M University to investigate the potential relationship between fingerprint pattern and ethnicity. The aim of the investigation was to provide insight into the relationship between ethnic characteristics and fingerprint patterns to better understand forensic science, anthropology, and the genetic diversity among humans.

## Materials and Methods

The purpose of this study was to evaluate the influence of ethnicity on fingerprint patterns among students at Texas A&M University. Two hundred fingerprints from students with various ethnic backgrounds were collected on campus. Participants were asked to self-identify their ethnicity with efforts made to ensure representation from various ethnic groups present on campus.

The fingerprints were collected by inking fingers with ink pads (Fingerprint Ink Pad, Black Thumbprint Ink) and lightly pressing all ten fingers on 3x5 notecards (Index Cards 3x5, Ruled Index Cards) (Fig. 2). Names and


**Fig 2.** One index card showing fingerprints collected with ink pads.

ethnicity were recorded on the lined side of the notecard while fingerprints were arranged as shown. Between each finger, hand wipes (Wet Ones Antibacterial Hand Wipes) were used to avoid cross-contamination between prints. Data analysis was done by visually determining the type of pattern each individual fingerprint exhibited using Level 1 fingerprint details. Data was put into a table based on the individual's ethnicity. The percentage for each pattern type was calculated in relation to the whole within each ethnic group. To protect the privacy of the participants, all data collected during the research period was handled with confidentiality and used strictly for research purposes.

## Results

Fingerprint patterns across the four ethnic groups showed variations regarding the occurrences of loops, whorls, and arches. Among the groups, loops showed to be the most common fingerprint pattern; however, the size of their predominance differed. Loops occurred with the highest frequency among Whites, where 69.92% of the fingerprints fell in this category, far higher than loop frequencies in the other groups. Asians had the lowest percentage of loops, 49.41%, indicating a closer balance in the distribution of fingerprint patterns within this group. Hispanics and Blacks presented 59.06% and 54.52%, respectively, but still contained more loops than other fingerprint patterns (Fig. 3).

Whorls were the second most frequent pattern, and their frequency was more apparent in Asians at 38.71%. Hispanics demonstrated a frequency of whorls at 30.38%, while the Black and White populations had lower proportions of 28.71% and 23.82%, respectively. The Black population had the highest occurrence of arches at 16.77%. Hispanics and Asians exhibited arches, with percentages of 10.57% and 11.88%, respectively. In contrast, Whites

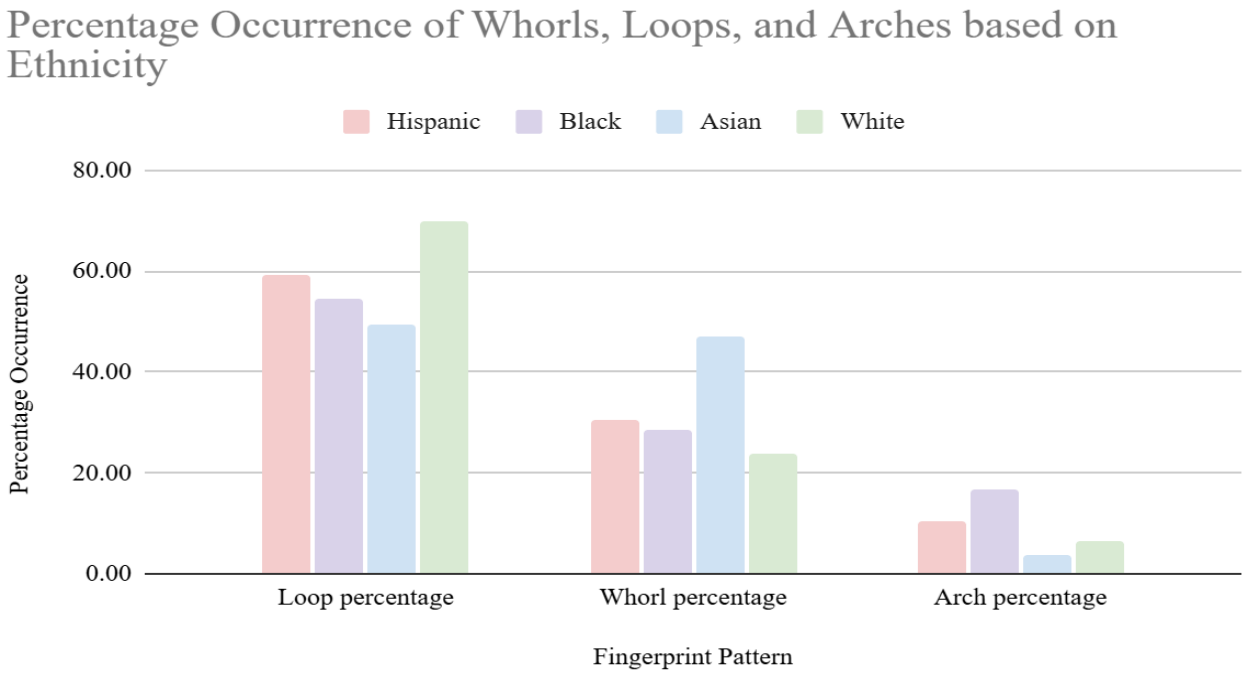


**Fig. 3** Percentage occurrence of whorls, loops, and arches based on ethnicity

displayed arches in 6.36% fingerprints (Fig. 3).

The radial loop pattern was the most frequent subtype in all the groups in the following order: Hispanics 55.66%, Blacks 50.32%, Whites 63.02%, and Asians 45.29%. The plain whorl was present in all the groups, with Hispanics presenting the highest frequency of 22.08%, while double and accidental whorls had appeared infrequently in all groups. In the arch category, plain arches were more frequent than tented arches. The Black population had the highest frequency of plain arches, 11.29%. Tented arches were the least common, occurring in less than 6% of individuals in all groups (Fig 4.).

## Discussion

Results obtained emphasize differences in fingerprint patterns among the different ethnic groups and possible associations with genetic and developmental factors. Differences in frequency distribution of the loops, whorls, and arches among Whites, Blacks, Hispanics, and Asians link to earlier dermatoglyphic studies, setting the context to unique patterns uncovered through the present study.

The predominance of loops, most notably in the White population (69.92%), was in line with earlier studies stating loops as the most prevalent fingerprint pattern globally. For example, studies on different populations, such as the Nepalese and Sinhalese groups, revealed loops as the most frequently occurring patterns, with variation in their actual frequencies from one population to another attributed to localized genetic influences (Shrestha and Malla 2019). The lower loop frequency in Asians (49.41%) observed in this study was similar to research

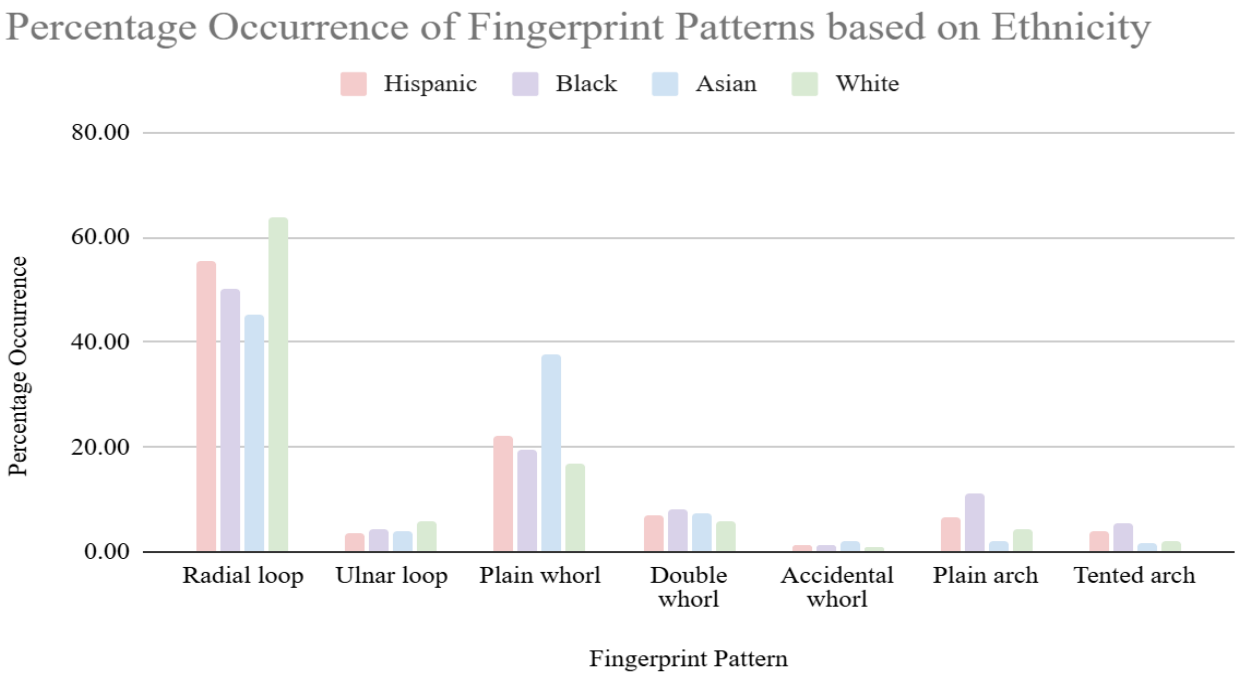


**Fig. 4** Percentage occurrence of fingerprint patterns based on ethnicity.

showing a more balanced distribution of fingerprint patterns in Asian populations, which implies both genetic diversity and evolutionary pressures (Zhang 2010 and Glover et al. 2022).

The higher prevalence of whorls in Asians (38.71%) compared to other groups relates to studies demonstrating unique fingerprint pattern trends in Asian populations. The detailed study of dermatoglyphics in Chinese ethnic groups, for example, recorded pattern frequency differences between northern and southern subpopulations that could provide a genetic or cultural explanation for the results reported in this study (Manikandan et al. 2019). On the other hand, the low whorl frequency of Whites at 23.82% indicates the specific fingerprint pattern of this population, which has also been seen in some European populations (Neiswanger et al. 2020).

Arches, the rarest type of fingerprint pattern, presents variation between the studied groups, being the highest in Blacks at 16.77% and lowest in Whites at 6.36%. This aligns with the general trend noted in various studies, showing that although arches are usually less common, their frequency was notably different across populations (Galton 1893, Neiswanger et al. 2020, Shrestha and Malla 2019).

When examining the subtypes of fingerprint patterns, the high occurrence of radial loops in all groups supports earlier research findings that loops tend to be the most common fingerprint pattern across different ethnicities (Galton 1893, Shrestha and Malla 2019). Likewise, the consistent presence of plain whorls in all groups compared to the infrequency of double or accidental whorls was similar to established dermatoglyphic

classification systems found in other studies (Galton 1893 and Manikandan et al. 2019).

The broader context from other dermatoglyphic studies reinforces the importance of these findings. Genetic research, including a study that pinpointed loci near EVI1 affecting fingerprint patterns, proves that the variations observed stem from developmental and genetic mechanisms that, since ethnicity has an impact on genetics, would agree with the idea that ethnicity is to play a role in fingerprint patterns (Glover et al. 2022). Additionally, population-based dermatoglyphic surveys conducted in countries like Spain and China illustrate how fingerprint patterns exhibit both inherited characteristics and demographic history (Manikandan et al. 2019 and Neiswanger et al. 2020).

This study showed the impact of genetic factors, including ethnicity, on fingerprint patterns. The notable differences found, such as the higher number of arches among Black participants and the more even distribution of loops and whorls in Asians, demonstrate that ethnicity influences dermatoglyphic traits. However, it is important to do further research with larger and more diverse sample sizes to ensure accurate findings. Additionally, while fingerprint patterns show trends at the group level, fingerprint characteristics are still specialized to the individual, meaning that dermatoglyphic patterns should not be seen as a definitive marker of ethnicity.

**Acknowledgments**

Thank you so much to my parents for being patient with me while I finished this project. Thank you to Dr. Adrienne Brundage for facilitating my quick change of topics, and to all the volunteers whose fingerprints I was able to collect with ease.

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