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# Comparative Study of Morphological Features of Hair in Five State of India For Forensic Consideration

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## *Abstract:*

*Hair is the most frequently found trace evidence in the crime cases. It assists in establishing a relation between a crime scene, a victim and a criminal. Morphology of hair can be helpful in forensic investigations to distinguish hair. In this context for the purpose of analysis, medulla, inner cuticle margin (distinct, indistinct & varied), cuticle thickness & scaling pattern were considered. Five different states (Uttar Pradesh, Kerala, Bengal, Jharkhand and Nagaland) were selected to analyze the structural similarity and dissimilarity from each other. Compound microscope was used for the purpose of observation. There was significant difference between five states of India. The purpose of study was to develop a data base by analyzing the cuticle thickness, inner cuticle margin, medulla, & scaling pattern in human head hair in different states of India to narrow down forensic analysis in crime scene investigation.*

***Keywords:*** *Morphological Features of Hair, Forensic Consideration*

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## Introduction

Hairs are a potentially ubiquitous trace material in several categories of forensic investigation. Hair is a protein filament which grows from follicles and further found in the dermis or skin. Hair is one of the defining features of the mammals. The human body apart from zones of glabrous skin is covered in follicles which produces thick terminal and fine vellus hair. The part beneath the skin is called as the hair follicle or when the same pulled from the skin considered as bulb. The length of hair extends from its root or bulb embedded in the follicle which continues into a shaft of the hair and terminates at a tip. The shaft of the hair is composed of three layers i.e., Cuticle, Cortex and Medulla. Cuticle is considered as the outermost layer of the hair, medulla is known as the innermost layer and cortex is considered as middle layer i.e. in between the cuticle and medulla. Hair is commonly encountered evidence on a crime scene which includes Murder, Homicidal, Sexual assault, accident or many more cases. Different states have different morphological features in hair depending upon their habitat, environment and their eating habits which can resulted into change in their scaling pattern, medulla, cuticle thickness etc. so the hair can be very useful evidence for forensic consideration and interpretation. Several researcher have contributed in this area of work. A review of previous research work done by different authors is compiled to get an idea about the study conducted in this field and to access the scope of future researches in this field.

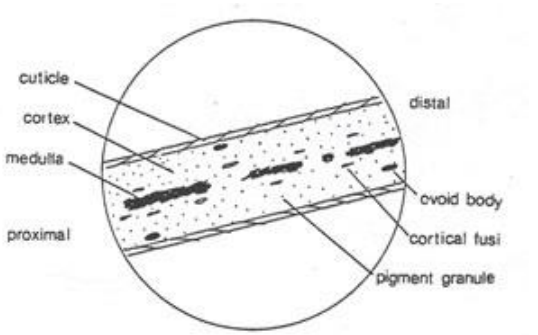



**Figure 1** Hair showing cuticle, cortex and medulla.

## Material and Methods

### Collection of Sample

The hair samples of different states were collected individually from Uttar Pradesh, Kerala, Jharkhand, Nagaland, and West Bengal and analysed for the identification of medulla, inner cuticle margin, cuticle thickness & scaling pattern. Shaded hair were collected from the individuals between the average age of 18-30 year and packed in sealed plastic bags.

In the present work 200 sample of hair were collected for the identification of medulla, inner cuticle margin, cuticle thickness and scaling pattern and analysed under the compound microscope. Out of 200 samples, 20 of male and 20 of females hair samples were collected from individual of each states.

### For morphological feature of hair

Hair samples were washed with acetone. Strand of a hair were dried, placed on a microscopic slide with a drop of glycerin covering the whole hair strand under a cover slip and was subjected to microscopically examination. Hair strands were observed under 10x & 40x resolution.

**For scaling pattern**

Considerable size of hair sample has been taken. Strand of a hair was placed on a microscopic slide and transparent nail paint is applied on it and left for five minutes. Than with the help of forceps hair sample was taken out. Than microscopic slide is observed under microscope under resolution of 40x.

**Results:**

The following results were obtained based on the hair analysis of the three parameters viz. cuticle thickness, inner cuticle margin and medulla pattern.

**Inner cuticle margin**

The inner cuticle margin was divided into three categories: distinct, indistinct and varied. Microscopic comparison of hairs from five state of India was done. The results showed that in males of **Uttar Pradesh** state sixteen samples observed as distinct, zero were indistinct and four showed varied results and females showed eighteen distinct types, two indistinct and zero varied types of inner cuticle margin. In case of males of **Nagaland** state, eighteen samples were distinct, two were indistinct and no samples were found to be varied, whereas in females nineteen were distinct samples, and one indistinct and no varied ones. In case of males of **West Bengal** showed that there were sixteen distinct samples, four samples were indistinct and again zero were varied types. Whereas in case of males of **Kerala**, twenty samples were observed as distinct, and no indistinct and varied were observed. In case of **Jharkhand males** eighteen samples were distinct, two were varied type and no indistinct type were observed, where as in case of female twenty were distinct and no indistinct and varied type inner cuticle margin were observed.

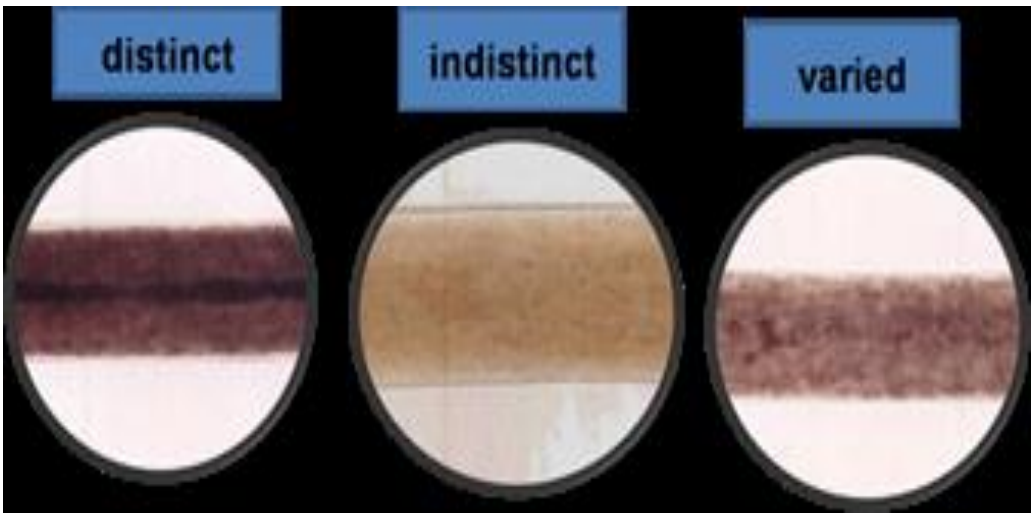



**Figure 2 Inner cuticle margin showing the different categories**

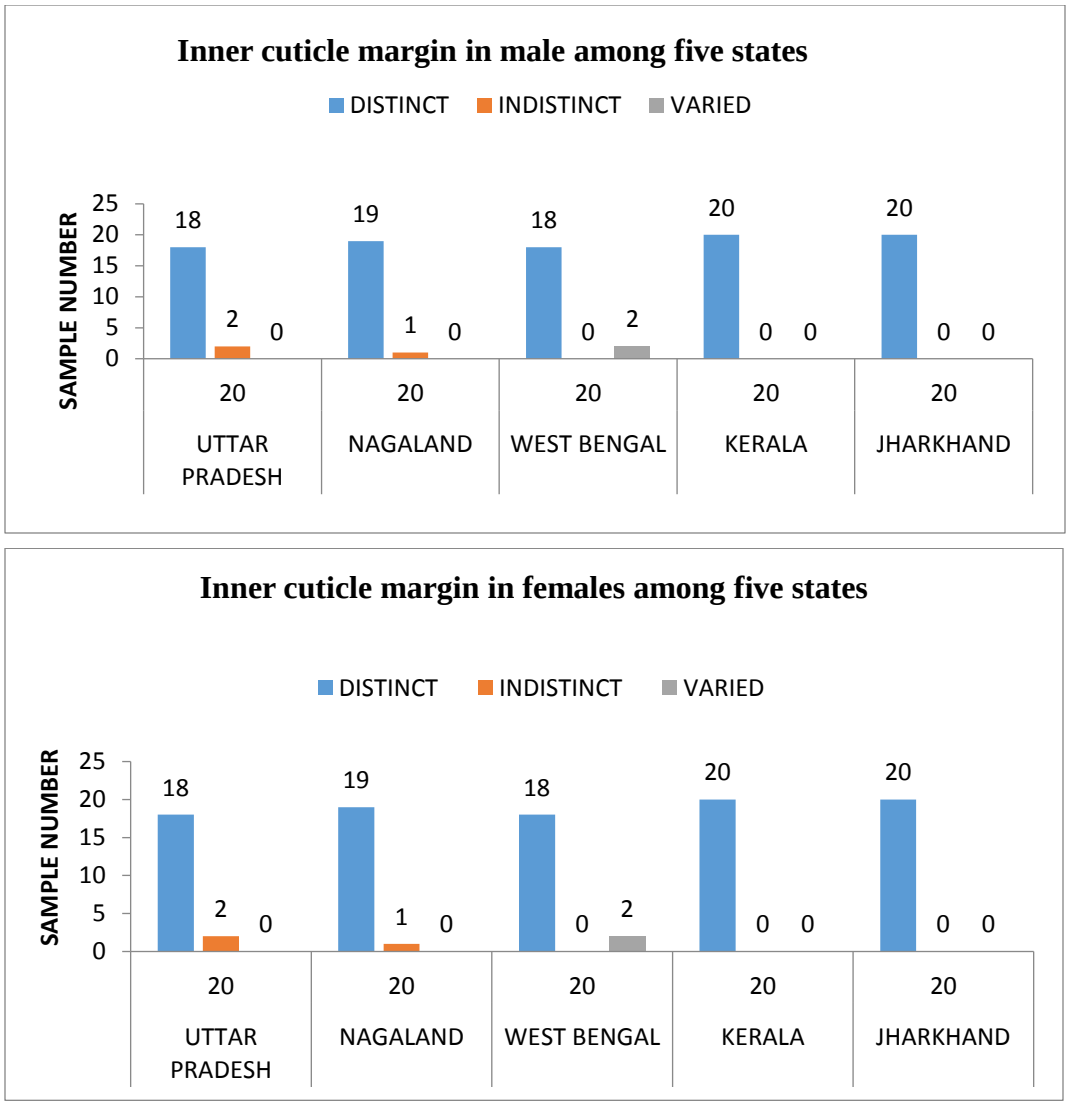



**Figure 3: Representation of graph showing inner cuticle margin in males and females among five states.**

**Table 1:-Distributions of distinct, indistinct and varied types observed in the inner cuticle margin in male & female among the states.**

| Inner cuticle Margin | Number of sample | Uttar Pradesh | | Nagaland | | West Bengal | | Kerala | | Jharkhand | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MALE | FEMALE | MALE | FEMALE | MALE | FEMALE | MALE | FEMALE | MALE | FEMALE |
| DISTINCT | 20 | 16 | 18 | 18 | 19 | 16 | 18 | 20 | 20 | 18 | 20 |
| INDISTINCT | 20 | 00 | 02 | 02 | 01 | 04 | 00 | 00 | 00 | 00 | 00 |
| VARIED | 20 | 04 | 00 | 00 | 00 | 00 | 02 | 00 | 00 | 02 | 00 |

**Cuticle thickness**

Samples which showed distinct inner cuticle margin were then further examined for cuticle thickness. For this parameter in male hair samples, **Uttar Pradesh** male sixteen samples were distinct from which twelve had thick cuticle and only four had thin. In case of **Nagaland**, eighteen samples showed distinct and sixteen of them appeared as thick and two had thin cuticle. In case of **West Bengal**, sixteen samples were distinct and in which twelve were thick and only four shows thin cuticle. In case of **Kerala** twenty sample show distinct in which eighteen were thick & two were thin while in case of **Jharkhand** eighteen samples were distinct in which sixteen were thick & two were thin.

In case of hair sample from females from **Uttar Pradesh**, eighteen samples were distinct in which sixteen had thick & two had thin cuticle, In case of female from **Nagaland** nineteen were distinct fifteen had thick & four had thin, In case of **West Bengal** eighteen were distinct in which fifteen had thick & three had thin, In case of female from **Kerala** twenty were distinct in which seventeen had thick & three had thin & In case of female from **Jharkhand** twenty samples were distinct in which sixteen had thick & four had thin cuticle.

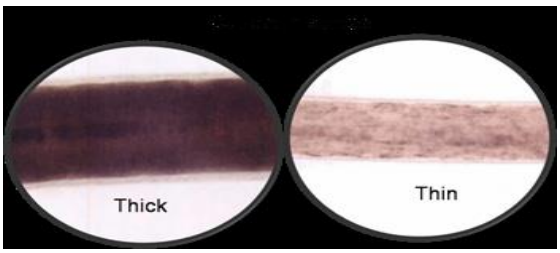
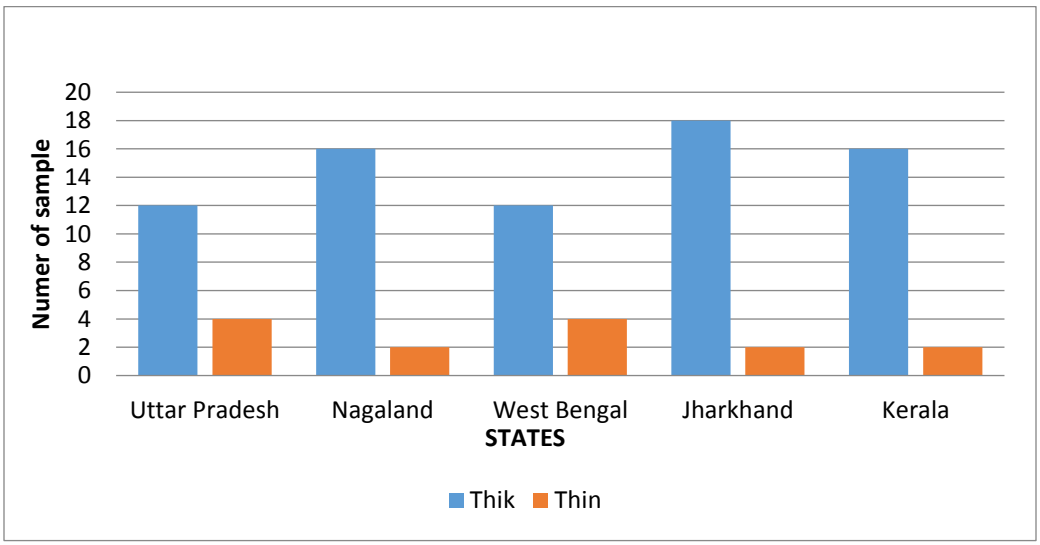



**FIG 4.4 Hairs showing thin and thick cuticle**



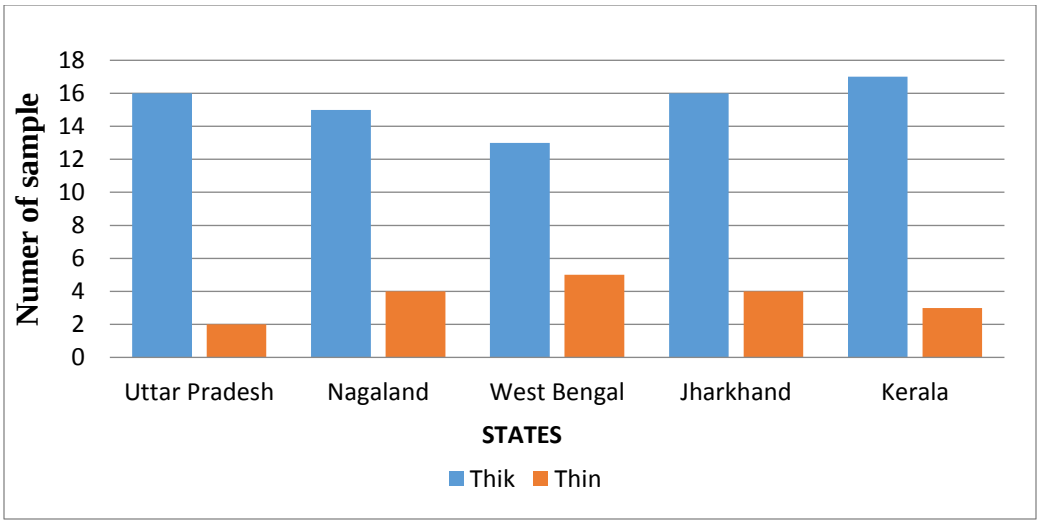



**Figure 4: Distribution of thick and thin cuticles in Males and Females hairs among states.**

**Table 4.2 Distributions of thin and thick cuticle in male & female among five states.**

| **Cuticle Thickness** | **Uttar Pradesh** | | **Nagaland** | | **West Bengal** | | **Kerala** | | **Jharkhand** | |
|---|---|---|---|---|---|---|---|---|---|---|
| | MALE | FEMALE | MALE | FEMALE | MALE | FEMALE | MALE | FEMALE | MALE | FEMALE |
| | n-16 | n-18 | n-18 | n-19 | n-16 | n-18 | n-20 | n-20 | n-18 | n-20 |
| THICK | 12 | 16 | 16 | 15 | 12 | 13 | 18 | 17 | 16 | 16 |
| THIN | 04 | 02 | 02 | 04 | 04 | 05 | 02 | 03 | 02 | 04 |

**Medulla -**

The central or innermost core of the hair, the medulla contains a collection of cells but appears as if it's an empty or mud-filled central canal. In human hairs, the medulla is generally amorphous in appearance. The medulla's appearance can be typed as continuous, fragmental and absent. The different types of medulla pattern are shown in Figure 4.7. The sequence of continuous medulla pattern in males is found be in the order of three in **Uttar Pradesh** followed by one in **Jharkhand and Kerala**, four in **Nagaland** and in **West Bengal** three whereas in females, the sequence is found to be in the order of four in **Uttar Pradesh** followed by two in **Jharkhand and Kerala**, four in **Nagaland and West Bengal**. The sequence of fragmented medulla pattern in males is found be in the order of seven in **Uttar Pradesh** followed by three in **Jharkhand and Kerala**, eight in **Nagaland** and five in **West Bengal** whereas in females, the sequence is found to be in the order of eight in **Uttar Pradesh** followed by two in **Jharkhand and Kerala**, ten in **Nagaland and** eight in **West Bengal**.

**FIG 4.7 Types of medulla pattern**

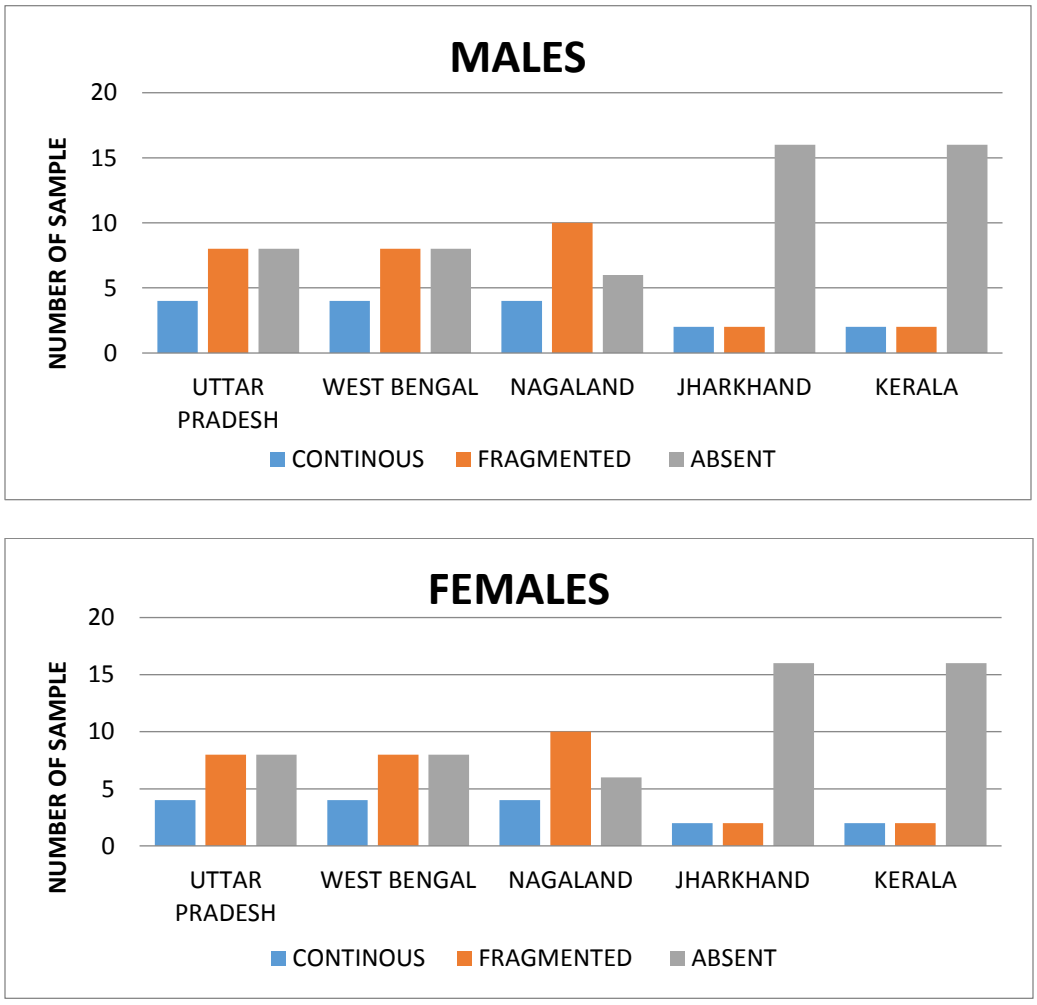



**Fig. 4.9 Distribution of hair medulla pattern in hairs of females among the states of India**

**Table 4.3 Frequency and percentage distributions of hair medulla pattern among states**

| MEDULLA PATTERN | UTTAR PRADESH | | | | JHARKHAND | | | | KERALA | | | | NAGALAND | | | | WEST BENGAL | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MALE | | FEMALE | | MALE | | FEMALE | | MALE | | FEMALE | | MALE | | FEMALE | | MALE | | FEMALE | |
| | N | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % |
| CONTINOUS | 3 | 7.5 | 4 | 10 | 1 | 2.5 | 2 | 10 | 1 | 2.5 | 2 | 10 | 4 | 10 | 4 | 10 | 3 | 7.5 | 4 | 10 |
| FRAGMENTED | 7 | 17.5 | 8 | 20 | 3 | 7.5 | 2 | 10 | 3 | 7.5 | 2 | 10 | 8 | 20 | 10 | 25 | 5 | 12.5 | 8 | 20 |
| ABSENT | 10 | 25 | 8 | 20 | 16 | 40 | 16 | 40 | 16 | 40 | 16 | 40 | 8 | 20 | 6 | 15 | 12 | 30 | 8 | 20 |

**Conclusion:**

In the present work, the sample of human hairs of different states were observed under compound microscope. The total numbers of observation were made on 200 hair samples in which medulla, cortex thickness, inner cuticle margin, & scaling pattern were observed. Out of 200 samples, 20 of male and 20 of females hair samples were collected from individual of each states.

In case of male hair sample the maximum number of distinct Inner cuticle margin was seen in Kerala and Jharkhand and minimum was seen in Uttar Pradesh and West Bengal. In case of indistinct inner cuticle margin maximum number was seen in Uttar Pradesh and minimum in case of West Bengal, Kerala, and Jharkhand. In case of varied inner cuticle margin maximum was seen in West Bengal and minimum was seen in Uttar Pradesh, Nagaland, Kerala and Jharkhand.

In case of female hair sample the maximum number of distinct Inner cuticle margin was seen in Kerala and Jharkhand and minimum was seen in Uttar Pradesh and West Bengal. In case of indistinct inner cuticle margin maximum number was seen in Uttar Pradesh and minimum in case of West Bengal, Kerala, and Jharkhand. In case of varied inner cuticle margin maximum was seen in West Bengal and minimum was seen in Uttar Pradesh, Nagaland, Kerala and Jharkhand.

In case of male hair sample maximum thick cuticle was seen in Jharkhand and minimum thick cuticle is seen Uttar Pradesh and West Bengal where as in case of thin cuticle maximum number was seen in Uttar Pradesh and West Bengal and minimum number was seen Nagaland, Jharkhand and Kerala.

In case of male hair sample Maximum number of continuous medulla is seen in Uttar Pradesh and West Bengal and minimum is found in Jharkhand and Kerala whereas Maximum no of fragmented

medulla is seen in Nagaland and minimum in Jharkhand and Kerala.

In case of female hair sample Maximum number of continuous medulla is seen in Uttar Pradesh Nagaland and West Bengal and minimum is found in Jharkhand and Kerala whereas Maximum no of fragmented medulla is seen in Nagaland and minimum in Jharkhand and Kerala.

In case of female hair sample maximum thick cuticle was seen in Kerala and minimum thick cuticle is seen West Bengal where as in case of thin cuticle maximum number was seen in West Bengal and minimum number was seen Uttar Pradesh.

This pilot study, the first of kinds in India highlights the morphological differences in hairs among the major states i.e., Uttar Pradesh, Kerala Nagaland, West Bengal and Jharkhand. The result of the study can be used to narrow down the suspects in crime scene investigations. Therefore the researchers are encouraged to conduct similar studies for different states living in different parts of the India so that the genetic and environmental effects can be investigated in forensic terms.

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