

# Sexual dimorphism and its forensic implications in human lanugo and vellus hair

## Abstract

Hair as an exoskeleton is a unique characteristic of mammals; Human hair is a highly versatile material with significant potential in several areas such as population classification, forensic science for personal identification and also from evolutionary perspectives. Many research reported sexual dimorphism of quantitative characters in adult terminal hair and thereby provided imperative roles in evolutionary aspects and personal identification. Apart from the three phases to hair growth such as anagen, catagen and telogen phases, the age of hair can be divided into three types such as the first hair, known as lanugo begins to grow on the entire body of the embryo at 3-4 months of pregnancy and falls out within 7-8 months, followed by vellus and terminal hair. To best of the knowledge this is the first attempt on Histomorphological and Quantitative variation of lanugo Hair consisted of 250 lanugo hair strands (125 males and 125 females) obtained from spontaneously aborted fetus (around 3 months) and 1650 vellus hair strands (Male 800 and female 850) obtained from the newborns. Before microscopy for histomorphological (medullation) and quantitative aspects (hair length in mm and shaft diameter in  $\mu\text{m}$ ), each hair strands were washed and cleaned following standard technique. The result demonstrated no histomorphological variation in lanugo hairs for both the sexes, since all strands were non-medullated. But in contrary to lanugo hair strands, vellus hairs showed medullated hair strands with significant ( $p < 0.05$ ) lower incidences in comparison to non-medullated scalp hair for both the sexes. However, the incidences of shaft diameter demonstrated significant ( $p < 0.05$ ) sexual variation (dimorphism) in terms of higher shaft diameter in vellus scalp hair among the females. The quantitative characteristic for example, hair length also demonstrated significant ( $p < 0.05$ ) sexual dimorphism indicating of higher vellus scalp hair length among the females than the males. Unlike the lanugo hair, the vellus hair revealed significant ( $p < 0.05$ ) sexual dimorphism for the both the hair length and shaft diameter. Interestingly, the present research vindicated significant ( $p < 0.05$ ) effect of hair growth (length and shaft diameter) from lanugo to vellus scalp hair for both the sexes. Therefore, the present study envisaged the sexual variation in fetal scalp hair for both the qualitative and quantitative aspects could have forensic implications.

**Keywords:** lanugo hair, vellus hair, medullation, quantitative variables

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## Introduction

Hair is defined as a slender, thread-like outgrowth from a follicle in the skin,<sup>1</sup> a unique characteristic of mammals.<sup>2</sup> Hair can be physically divided into three parts, i.e. cuticle, medulla and cortex.<sup>3</sup> Among these histological structures of human head hair, the medulla has received the foremost importance since 1924 and has been studied<sup>4,5</sup> with respect to age, race and sex variation. According to age hair can be divided<sup>6</sup> into three types; lanugo, vellus and terminal hair. The first hair, known as lanugo which begins to grow on the entire body of the embryo in uterus beginning at 3-4 months of pregnancy and falls out at 7 or 8 months of pregnancy. A new hair follicle is formed prior to 2-3 months of birth where the lanugo falls out and vellus grows on the skin. At puberty vellus hair turned into or replaced<sup>7,8</sup> by terminal hair. Although Haddon (1924)<sup>9</sup> was the first who had attempted to utilize head hair forms as a category for ethnic classification but now a days it have been studied invariably by a number of researchers from different fields such as; Comparative Anatomist, Medico Legal Expert, Plastic Surgeon, Endocrinologist, Cosmetologist, Students of human races, Anthropologists and Experts of Individualization and

specially in Forensic science<sup>10-12</sup> because of several reasons. Among them most important one is the presence of wide range of inter and intra-personal variations in the morphological features of hair which are primarily based on detailed microscopic observation<sup>13,14</sup> of the physical properties either qualitative or quantitative.

Furthermore, sexual dimorphism of hair is also an important key for personal identification<sup>15</sup> in human. Sexual dimorphism is not only the differences in the sex organs but also the existence of physical differences (Hair) between the sexes. Although for understanding of sexual dimorphism recent studies are focusing on human skin and hair coloration, as well as in some skeletal and dermatoglyphic characters<sup>16-19</sup> but microscopic studies of hair in terms of histological and qualitative variabilities were found<sup>20</sup> to be inexpressive and inexpensive. There are a few studies on the sexual dimorphism of hair<sup>15,16,21</sup> and conducted on adult hairs, but few studies included fetal hair to some extent<sup>22-24</sup> and a recent study had been attempted on lanugo hair,<sup>25</sup> as comparative studies on sexual dimorphism of lanugo (fetal) hair. However, the studies on vellus (new born) hair are scanty and/or not available.

With the above mentioned idea the present study is the first attempt;

- To understand the histomorphological characteristics (length and medullation) and quantitative aspects (shaft diameter) with reference to forensic implication regarding sexual variation (Dimorphism) of the lanugo and vellus scalp hair.
- To discern the sexual variation (dimorphism) of lanugo and vellus scalp hair

## Materials and methods

The material for the present study consisted of hair samples from 10 spontaneously aborted fetuses (3 intra uterine months) consisting 5 male and 5 females from Bengalee Hindu Caste population. 25 hair strands from each fetus were taken for examination of medullation, hair shaft diameter and length. Thus the total number of hair strands studied was 250. Sex determination of the fetus was done by utilizing the nuclear sexing method. In addition to that, 1650 scalp vellus hair strands (Male 800 and female 850) obtained from the newborns for the analysis of sexual variation (dimorphism). The hair samples were collected directly from the occipital region of the scalp of the fetuses by scraping with a sharp blade. Each of the hair strands were washed and cleaned using standard technique<sup>26</sup> and then were soaked and dried in room temperature. For microscopical study for the both histomorphological and quantitative variables (shaft diameter), each washed hair strand was mounted on microscopic glass slides with 40 x ocular microscope (Binoculour: Letiz, WETZLAR, Germany) with 0.65 objective resolutions. On the other hand for quantitative variables the above mentioned resolution was used and measurements have been obtained in  $\mu\text{m}$  by micrometer fitted with the microscope. Diameter of the shaft was measured at the three points- root, mid-point and tips (approx.) then the mean was taken. The lengths of the each shaft were measured by slide-caliper (Martin's) in mm. The data was tested for Q-Q plot and found to be in normal distribution. The cut off was set as  $p=0.05$ .

## Results

Length of the strands (Table 1) demonstrated significant ( $p<0.05$ ) sexual variation (dimorphism), in terms of higher hair lengths in female compared to the males of same intra uterine months. On the other hand no sexual dimorphism has been found in shaft diameter. Unlike the fetal hair, both length and diameter of vellus hair strand (Table 2) demonstrated significant ( $p<0.0001$ ) sexual variation (dimorphism), indicated higher hair lengths and shaft diameter among the females compared to the males of same age. Examination on the histomorphological characteristics of the lanugo hairs (Table 3) revealed no medullation. But in contrary, the newborns (Table 3) discerned vellus hair which replaces the Lanugo hair (fetal hair) evinced by medullary character, but the incidences of non-medullated scalp hair was significantly ( $p<0.0001$ ) excess in both the sexes. Furthermore, significant ( $p<0.05$ ) excess of medullated vellus hair among the females than the males of the same age indicated significant sexual dimorphism.

**Table 1** Distribution of length and shaft diameter of the lanugo hair according to the sex

Name of the group	Length (mm)	Diameter ( $\mu\text{m}$ )
	Mean $\pm$ SD	Mean $\pm$ SD
Male (n=125)	2.35 $\pm$ 1.29	17.98 $\pm$ 3.39
Female (n=125)	3.00 $\pm$ 2.29*	18.19 $\pm$ 2.83

\* $p<0.05$

**Table 2** Distribution of length and shaft diameter of the vellus hair according to the sex

Name of the group	Length (mm)	Diameter ( $\mu\text{m}$ )
	Mean $\pm$ SD	Mean $\pm$ SD
Male (n=800)	23.35 $\pm$ 5.66	31.29 $\pm$ 5.75
Female (n=850)	29.03 $\pm$ 5.50*	34.40 $\pm$ 6.80*

\* $p<0.0001$

**Table 3** Distribution of medullation of lanugo and vellus hair according to the sex

Medullary Type	Lanugo (Fetal) Hair		Vellus (New Born) Hair	
	Male (n=125)	Female (n=125)	Male (n=800)	Female (n=850)
Non-medullated	125 (100)	125 (100)	705 (88.12)	633 (74.47)
Medullated	-	-	95 (11.88)	217 (25.53)

Figures in the (parenthesis) denotes the percentage

Interestingly, the present research vindicated histomorphological changes, such as from completely non-medullated lanugo hair to appearance of medullation in vellus hair. In addition to that significant ( $p<0.05$ ) effect of hair growth in terms of length and shaft diameter from lanugo to vellus scalp hair for both the sexes.

## Discussion

Examination on the histomorphological characteristics of the present attempt revealed the occurrence of entirely non-medullated lanugo scalp hairs, obtained from the spontaneously aborted fetus of 3 months but the vellus hair which replaces the Lanugo hair (fetal hair) demonstrated the medullary character. It appears from the foregoing study that the hair samples of fetus shows less variation in quantitative characters except the hair length, while in case of vellus hair both the length and diameter demonstrate significant ( $p<0.05$ ) sexual variation, which is corroborative<sup>22-24</sup> with the earlier studies. Since sexual dimorphism is one of the major factors for evolutionary process and implicate importance in forensic researches. The present study envisaged that, sexual dimorphism of hair histomorphological (medullation) and quantitative characters (length and shaft diameters) could be sufficiently reliable as an important and inexpensive method of forensic study even in fetal and newborn hair.

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## Conflicts of interest

There is no Authors' Potential Conflict of interest.

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