# CHAPTER -I

# INTRODUCTION

A fingerprint is an impression left by the friction ridges of a human finger. The recovery of a partial fingerprint from a crime scene is an important method of forensic science [3]. Moisture and grease on a finger result in fingerprints on surfaces such as glass or metal. Deliberate impressions of entire fingerprints can be obtained by ink or other substances transferred from the peaks of friction ridges on the skin to a smooth surface such as paper [2]. Fingerprint records normally contain impressions from the pad on the last joint of fingers and thumbs, though fingerprint cards also typically record portions of lower joint areas of the fingers. Human fingers are detailed, nearly unique, difficult to alter, and durable over the life of an individual, making them suitable as long-term markers of human identity. They may be employed by police or other authorities to identify individuals who wish to conceal their identity, or to identify people who are incapacitated or deceased and thus unable to identify themselves, as in the aftermath of a natural disaster [5]. No two people have exactly the same fingerprints. Even identical twins, with identical DNA, have different fingerprints. The uniqueness allows fingerprints to be used in all sorts of ways, including for background checks, biometric security, mass disaster identification, and of course, in criminal situations[1].

Fingerprint analysis has been used to identify suspects and solve crimes for more than hundred years, and it remains an extremely valuable tool for law enforcement [3]. One of the most important uses for fingerprints is to help investigators link one crime scene to another involving the same person. Fingerprint identification also helps investigators to track a criminal's record, their previous arrests and convictions, to aid in sentencing, probation, parole and pardoning decisions [6]. Stature is used for constructing a biological profile that assists with the identification of an individual [2]. So far, little attention has been paid to the fact that stature can be estimated from hand impressions left at scene of crime.

The determination of stature is an important step in the identification of dismembered remains. Anthropometric techniques are commonly used by anthropologists and adopted by medical scientists to estimate body size for the purpose of identification. Personal identification plays a vital role in medico-legal and crime scene investigation. In this context, stature is considered as one of the big four parameters required to assist with the identification of an individual when other lines of evidence are corroborative [4]. The knowledge of definite relationship between various body dimensions can be useful in estimating stature of an unknown person [6].

Often the only evidence that may be available at the scene of a crime is in the form of latent impressions from hands and fee t[2]. In such cases, the impression can be used to estimate stature of the unknown person. The identification of commingled mutilated remains is a challenge to forensic experts and hence, a need of studies on estimation of stature from various body parts in different population groups. Such studies can help in narrowing down the pool of possible victim matches in cases of identification from dismembered remains [7]. Relationship that exists between different part of the body and height had been of great interest to anthropologists, forensic and medical scientists for many years. This is because of the increase in the number of catastrophic events causing mass deaths from natural or manmade errors. Such disasters like flooding, earthquakes, plane crashes, train crashes, terrorist attacks usually requires the identification of victims from fragmentary and dismembered human remains. Earlier reports have shown that relationship exists between stature and hand length and foot length, stature and shoe dimension, stature, tibial length and malleolar breadth. The investigators or fingerprint experts us edto mention crime scene finger prints as “chance finger prints”, since the fingerprints are left by chance by the perpetrators while committing crime [5].

Stature is an identifying characteristic which provides useful information to solve the crime. Examination of foot, footprint, hand, handprint and fingers help in estimation of an individual’s stature because of the existence of a strong correlation between one’s stature and hand, foot size [5]. It is known fact that chance prints are available in most of the crime scenes wherein the tip portion of the impression is

mostly found as “latent finger prints” in the indoor crime scenes which are then enhanced by various techniques like applying various fingerprint powders, glues and forensic lights[9]. Fingers are constructed of ligaments (strong supportive tissue connecting bone to bone), tendons (attachment tissue from muscle to bone), and three phalanges (bones).The first bone, closest to the palm, is the proximal phalange; the second bone is the middle phalange; and the smallest and farthest from the hand is the distal phalange. The thumb does not have a middle phalange [5]. Mostly the distal phalanges impressions are found in abundant in crime scenes as latent finger prints. Stature or body height is one most important and useful anthropometric parameter that determines the physical identity of an individual.

Stature prediction occupies relatively a central position in anthropometric research. Anthropometric technique commonly used by anthropologists and adopted by medical scientists has been employed to estimate stature for over a hundred years [3]. Stature provides insight into various features of a population including nutrition, health and genetics; geographical location, environment and climatic condition. The stature of an individual is an inherent characteristic; its estimate is considered to be an important assessment in the identification of unknown human remains[8]. There is an established relationship between stature and various body parts like head, trunk, upper and lower extremities. It is common to find the peripheral parts of the body such as hand and foot in explosions, aircraft and railway accidents. Stature is an identifying characteristic which provides useful information to solve the crime. Fingerprint is valuable physical evidence found in crime scenes like burglary, homicide, sexual assault and so on[4].The present study is aimed to estimate stature from fingerprint measurements in Keralites for forensic investigation. The study involved 80 Keralite participants (40 males and 40 females) age ranged from 16 to 30 years. The subjects were from schools, colleges, universities and general public in Kerala.

# CHAPTER - II

# LITERATURE REVIEW

Nasir Ahemad, M.Sc, et.al. (2011) this study is based on estimation of stature from hand impression: A nonconventional approach stature is used for constructing a biological profile that assists with the identification of an individual. The present study based on practical observations adopted a new methodology of measuring hand length from the depressed area between hypothenar and thenar region on the proximal surface of the palm. Stature and bilateral hand impressions were obtained from 503 men of central India. Seventeen dimensions of hand were measured on the impression. Linear regression equations derived showed hand length followed by palm length are best estimates of stature. Testing the practical utility of the suggested method on latent prints of 137 subjects, a statistically insignificant result was obtained when known and estimated stature derived from latent prints was compared. The suggested approach points to a strong possibility of its usage in crime scene investigation; albeit the fact that validation studies in real-life scenarios are performed.

RS Guerra, et.al (2013) this study is based on hand length as an alternative measurement of height. Despite the utmost importance of body height in evaluating nutritional status, it is not always possible to obtain its measurement and height may have to be estimated. The objective of the study was to formulate and cross-validate a regression equation to predict height using hand length measurement and also to determine if predicted height(PH) will lead to significant errors when used in body mass index (BMI) calculation. A cross-sectional study was conducted using a consecutive sample of 465 inpatients (19–91 years), from a university hospital. Participants were randomly divided into a development sample of 311 individuals and a cross-validation one. A linear regression model was used to formulate the equation.

Interclass correlation coefficients (ICCs) for single measures and differences between measured height (MH) and PH and between BMI calculated with MH (BMIMH) and with PH (BMIPH) were determined. Conclusions of this study is, formulated regression equation using hand length, age and gender provides a valid estimation of height and is useful in the clinical context. PH from this regression equation can be used in BMI calculations as misclassification is small.

Rajesh Vaijnathrao Bardale, et.al. (2013) this study is based on the estimation of stature from index and ring finger length establishing the identity of person is one of the significant aspects of Forensic investigation. The purpose of present study was to evaluate utility of index and ring finger lengths in estimation of stature and to predict the accuracy of regression models derived from such parameters. The study was carried out on a cross sectional sample of 195 adult students out of which 100 were males and 95 were females. There was significant difference ($P < 0.001$) between stature of male and female subjects. Similarly significant difference ($P < 0.001$) exists between male and female index and ring finger length. A significant correlation was observed between finger length and stature. Pearson correlation between finger length and stature was higher among females than males. The findings of present study indicate that index finger and ring finger lengths can be used successfully to predict living stature of an individual.

Jyoti Agrawal, et.al. (2013) this study is based on the estimation of stature from hand length and length of phalanges. The study was done to estimate stature from the hand and length of phalanges. Descriptive cross sectional study was conducted. This was conducted in the department of Anatomy, Dr.S.N. Medical College, and Jodhpur. One hundred males and one hundred females with the age of 18to 25yrs of, Dr.S.N. Medical College, Jodhpur. Measurement of stature using Stadiometer and hand length and phalangeal length of right hand with a slide caliper respectively. The present study showed significant correlation between the stature and hand lengths and phalangeal length. Provide multiplication factors for stature with other parameters.

Reekee Patel, et.al. (2014) this research is based on a study of estimation of stature from hand length in Gujarat. Personal identification is an integral part of the investigation in cases of mass disasters where disintegrated and amputated body organs are found very frequently. Establishment of an identity is very essential in Forensic Medicine in case of unknown individual, incomplete skeletal remains and decomposing bodies. Various factors such as race, geographical area, age, gender etc. affect the growth and development of individual. So regression formula should be population specific. So it is necessary to assess the extent to which hand length could be used to predict the stature in natives of Gujarat state and to yield the linear regression equation to estimate the stature in relation to hand length for males and females. Total 200 subjects within age group of 17 to 21 years were included in study. The hand length was measured using a spreading calliper. The height of individual was measured. A positive correlation between height and hand length was observed in both sexes and it was statistically significant. Regression formulae for stature estimation were formulated using the hand length for both sexes. So the data will be useful to forensic experts, archaeologists and anthropologists.

Karim Rezwan Hasan, et.al(2017) this study is based on the correlation of index finger length (2D) with height, weight and BMI in adult Bangladeshi male. By virtue of evolution and genetic arrangements, digital lengths vary from person to person according to age, sex, races, occupation or even environmental influences. It has been found that the digital lengths and their ratios are not same in different sexes and even in both hands of same individual. Specially, index to ring digit lengths and their ratios which already have been proved to represent sexual dimorphism may differ in both hands of an individual and show positive correlations with other morphological attributes like height, weight and BMI. This study is to analyze the variation of index finger (2D) length and its correlation with height, weight and BMI in adult Bangladeshi male. This cross-sectional analytical study was conducted in the department of Anatomy, Dhaka Medical College, Dhaka from July 2012 to June 2013 on 100 male MBBS students (20−25 years of age).

With the help of digital vernier caliper measurements of index finger length (2D) was recorded. Height and weight were measured by the stadiometer and weighing scale respectively. BMI was calculated from height and weight. Pearson's correlation analysis was done to find out the correlation of index finger length with height, weight and BMI. In this study, it is found that variation in index finger lengths of both hands of Bangladeshi male subjects, which needs further study and comparison.

Katwal B, et.al. (2017) this study is based on the estimation of stature from length of middle finger among Nepalese medical student of Nepal Medical College and Teaching Hospital. The present study was undertaken to evaluate the correlation between right middle finger length and stature of Nepalese population of Kathmandu in order to derive a formula for estimation of height for this population. A total of 200 M.B.B.S students between 18-25 years of age were included in this study. Stature of each individual was measured using a stadiometer with head positioned in Frankfurt plane. The middle finger length was measured using a Vernier caliper from the proximal mid-point to the tip of right middle finger. A linear regression equation was derived for stature estimation from right middle finger length in both the sexes. Pearson coefficients were used to correlate the relationship between stature and MFL. The mean stature of males was 170.02 cm and mean of middle finger length was 7.79 cm. Pearson correlation coefficient (0.422) obtained showed high significant correlation between right middle finger length and the height. The mean stature of females was 157.76 cm and mean of middle finger length was7.43cm. Pearson correlation coefficient (0.442) obtained showed high significant correlation between middle finger length and the height. This study showed good correlation between middle finger length and stature among males and females. The obtained regression equations can be used for estimation of stature of this regional population.

Athfiyatul Fatati, et.al. (2018) this study is based on the forensic body height estimation by measuring unsegmented fingers of Javanese in Indonesia. Estimation of stature is important in forensic examination. It is difficult to identify the deceased when the body has been mutilated and only fragmented remains are found. Body height estimation from fingers has been useful in establishing stature approximation. The present research attempts to construct a formula from measurements of the whole fingers from proximal to distal ends. The material for the present study comprises fifty (50) Mongoloid Javanese men between the ages of 21 and 25 years. Measurement of fingers and stature are taken on each subject based on internationally recommended standard methods and techniques. This study uses Pearson correlation test, and Regression analyses to determine the body height formula. The results indicate average height of the subject is 1675.96 mm. The results of index, middle, and ring finger measurements are positively correlated ($p < 0.001$) with stature. There are moderate correlations between the length of fingers and body height. It can be concluded measuring each segment of finger can provide an estimation of stature.

Charmode SH, et.al. (2019) this study is based on the correlation of human height with hand dimensions: A study in young population of central India. Identification of sex, age, race and stature is the most important aspect of any forensic investigation. There is a strong correlation of stature with hand dimensions and if either of the measurements is known, the other can be calculated. With this objective, the present study was designed to correlate the hand dimensions with stature of an individual and to record the standard deviation in the estimation of stature. This cross-sectional study was conducted amongst 1000 participants (500 male and 500 female) of ESIC Institute Gulbarga over a period of 14 months. Hand dimensions along with stature and weight were measured. Linear regression coefficient was calculated. Mean stature was 161.88 cm. Mean hand length was 18.11 cm on right side and 18.10 cm on left side. Mean hand breadth was 9.91 cm on right side and 9.83 cm on left side. Highly significant difference in right and left side mean hand length and breadth measurements was observed.

Also observed was a strong positive statistically significant correlation between height and hand dimensions. This data might be useful for forensic, epidemiological and anthropometric studies where stature determination is of utmost importance.

Md. Asadujjaman, et.al. (2019) this study is based on the stature estimation from hand anthropometric measurements in Bangladeshi population. The aim of this research was to generate a standard formula for estimating stature in the Bangladeshi population from hand anthropometric measurements. Arbitrarily selected a total of 150 male and 150 female healthy subjects within the age range 18–60 years participated in this study. Stature and nine hand parameters were taken using a standard tape and a digital slide calipers for each subject. The results indicate that in male Bangladeshi population, the bilateral variation of hand length, hand breadth, maximum hand breadth, palm length, thumb length, ring finger length, and little finger length was statistically not significant ($p > 0.05$). On the other hand, in female, bilateral difference of hand length, hand breadth, palm length, index finger length, middle finger length, ring finger length, and little finger length was statistically insignificant ($p > 0.05$). All hand dimensions were statistically significant ($p < 0.001$) and positively correlated with stature. Linear and multiple regression equation were used to estimate stature from hand anthropometric measurements. The accuracy of the determination of stature using hand dimensions ranged from±3.688 to±6.112 cm. Right-hand length was the most reliable single variable in both sexes in simple linear regression (SSE±5.347 cm in maleand±3.688 cm in female). The multiple regression models were more reliable than the linear regression models as a lower SSE and higher R and R-square values. In conclusion, our present study has a great importance to estimate stature from hand measurements among Bangladeshis from the anatomical and forensic point of view.

# CHAPTER - III

# AIM AND OBJECTIVES

**Aim:**

Estimation of stature from fingerprint measurements.

**Objectives:**

- To identify the stature of an individual from the fingerprint lengths.
- To analyze the variation of fingerprint length and correlation with height of population in Kerala.
- To find the regression equation for estimating the stature of male and female.

# CHAPTER - IV

# MATERIALS AND METHODOLOGY

**Materials Required:**

1. Stadiometer
2. Fingerprint ink
3. Fingerprint roller
4. Glass slab
5. Fingerprint collection slip
6. 250mm digital sliding calipers

**Methodology:**

The study subjects consist of 80Keralites (40 males and 40females) and the subjects were from colleges, universities and general public in Kerala. The age of the participants is ranged from 16 to 30 years. Informed consent and ethical approval were obtained following the standard procedure. The stature was measured without head and footwear using a portable body meter measuring device. The cleaned hand was placed on a fingerprint inked plate with mild pressure and then impressed on a fingerprint slip. The measurements of thumb fingerprint, index fingerprint, middle fingerprint, ring fingerprint and little fingerprint of both left and right hand is taken.


**Fig 1. Land marks and measurements of fingerprints on the right hand print**

The land marks and measurement of fingerprints on the right hand print are depicted in Figure 1. A total of ten anthropometric measurements, five lengths in left handprint and five lengths in right handprints were taken and recorded. It is the straight distance between the most forwarding projecting points on the tip of the fingerprint to the distal digital crease mark.

**Fingerprint length measurements in right handprint**

- AT – length, measurement taken from anterior point of thumb fingerprint to the distal digital crease.
- AI – length, measurement taken from anterior point of index fingerprint to the distal digital crease.
- AM – length, measurement taken from anterior point of middle fingerprint to the distal digital crease.
- AR – length, measurement taken from anterior point of ring fingerprint to the distal digital crease.

- AL – length, measurement taken from anterior point of little fingerprint to the distal digital crease.

  Both left and right hand finger print lengths were measured by using a 250 mm digital sliding caliper. Correlation coefficient (R) between various fingerprint lengths and stature was obtained.

**Fig II. Fingerprint roller**


**Fig III. Fingerprint slab**


**Fig IV. Fingerprint ink**

**Fig V. Stadiometer**

# CHAPTER - V

## OBSERVATIONS

Table 1. The table shows the database of 40 male subjects

| Samples | Gender | Mean Fingerprint Length | Actual Height | Predicted Height |
|---|---|---|---|---|
| 1 | M | 2.38 | 136 | 139.2107043 |
| 2 | M | 2.61 | 150.5 | 145.114854 |
| 3 | M | 2.64 | 143 | 145.8849605 |
| 4 | M | 2.45 | 143 | 141.0076194 |
| 5 | M | 2.63 | 132 | 145.6282583 |
| 6 | M | 2.43 | 142 | 140.4942151 |
| 7 | M | 2.49 | 144.5 | 142.034428 |
| 8 | M | 2.76 | 145.5 | 148.9653864 |
| 9 | M | 2.3 | 128 | 137.157087 |
| 10 | M | 2.25 | 131 | 135.8735762 |
| 11 | M | 2.75 | 153 | 148.7086842 |
| 12 | M | 2.8 | 153.5 | 149.9921951 |
| 13 | M | 2.62 | 140.5 | 145.3715561 |
| 14 | M | 2.44 | 172.8 | 140.7509172 |
| 15 | M | 2.5 | 137.2 | 142.2911302 |
| 16 | M | 2.73 | 140.3 | 148.1952799 |
| 17 | M | 2.48 | 140 | 141.7777259 |
| 18 | M | 2.44 | 152.5 | 140.7509172 |
| 19 | M | 2.74 | 148.5 | 148.4519821 |
| 20 | M | 2.56 | 130 | 143.8313432 |
| 21 | M | 2.3 | 141.5 | 137.157087 |
| 22 | M | 2.35 | 135 | 138.4405978 |
| 23 | M | 2.67 | 160 | 146.655067 |
| 24 | M | 2.67 | 149 | 146.655067 |

| | | | | |
|---|---|---|---|---|
| 25 | M | 2.48 | 133.5 | 141.7777259 |
| 26 | M | 2.85 | 155 | 151.2757059 |
| 27 | M | 2.44 | 138.5 | 140.7509172 |
| 28 | M | 2.43 | 136 | 140.4942151 |
| 29 | M | 2.61 | 142.5 | 145.114854 |
| 30 | M | 2.56 | 150.5 | 143.8313432 |
| 31 | M | 2.42 | 150 | 140.2375129 |
| 32 | M | 2.52 | 130 | 142.8045345 |
| 33 | M | 2.59 | 140 | 144.6014497 |
| 34 | M | 2.34 | 144 | 138.1838956 |
| 35 | M | 2.52 | 139 | 142.8045345 |
| 36 | M | 2.56 | 152 | 143.8313432 |
| 37 | M | 2.61 | 145 | 145.114854 |
| 38 | M | 2.55 | 149 | 143.574641 |
| 39 | M | 2.4 | 138 | 139.7241086 |
| 40 | M | 2.48 | 134 | 141.7777259 |

Table 2. The table shows the database of 40 female subjects

| Samples | Gender | Mean Fingerprint Length | Actual Height | Predicted Height |
|---|---|---|---|---|
| 1 | F | 2.24 | 128 | 132.5467537 |
| 2 | F | 2.17 | 129 | 131.492724 |
| 3 | F | 2.42 | 138 | 135.2571159 |
| 4 | F | 2.19 | 138.6 | 131.7938753 |
| 5 | F | 2.12 | 133 | 130.7398456 |
| 6 | F | 2.06 | 122.2 | 129.8363915 |
| 7 | F | 2.19 | 137.5 | 131.7938753 |
| 8 | F | 2.27 | 128.5 | 132.9984808 |
| 9 | F | 2.19 | 125.5 | 131.7938753 |
| 10 | F | 2.22 | 135.5 | 132.2456024 |

| | | | | |
|---|---|---|---|---|
| 11 | F | 2.22 | 133.3 | 132.2456024 |
| 12 | F | 2.34 | 131.5 | 134.0525105 |
| 13 | F | 2.13 | 133 | 130.8904213 |
| 14 | F | 2.34 | 128 | 134.0525105 |
| 15 | F | 2.16 | 126 | 131.3421483 |
| 16 | F | 2.11 | 136 | 130.5892699 |
| 17 | F | 2.16 | 135 | 131.3421483 |
| 18 | F | 2.46 | 137 | 135.8594186 |
| 19 | F | 2.19 | 133 | 131.7938753 |
| 20 | F | 2.1 | 127 | 130.4386942 |
| 21 | F | 2.22 | 125 | 132.2456024 |
| 22 | F | 2.29 | 130 | 133.2996321 |
| 23 | F | 2.31 | 134 | 133.6007835 |
| 24 | F | 2.21 | 130 | 132.0950267 |
| 25 | F | 2.23 | 131 | 132.396178 |
| 26 | F | 2.12 | 134 | 130.7398456 |
| 27 | F | 2.11 | 130 | 130.5892699 |
| 28 | F | 2.34 | 140.5 | 134.0525105 |
| 29 | F | 2.01 | 130.5 | 129.0835131 |
| 30 | F | 2.48 | 143.5 | 136.16057 |
| 31 | F | 2.34 | 131.5 | 134.0525105 |
| 32 | F | 2.18 | 136 | 131.6432996 |
| 33 | F | 2.39 | 131 | 134.8053889 |
| 34 | F | 2.35 | 130.5 | 134.2030862 |
| 35 | F | 2.35 | 136 | 134.2030862 |
| 36 | F | 2.4 | 130.5 | 134.9559646 |
| 37 | F | 2.06 | 125 | 129.8363915 |
| 38 | F | 2.21 | 132 | 132.0950267 |
| 39 | F | 2.33 | 142 | 133.9019348 |
| 40 | F | 2.04 | 138 | 129.5352401 |

Table 3. The table shows the regression statistics for male and female

| **Regression Statistics** | Male | Female |
|---|---|---|
| Multiple R | 0.406636486 | 0.367881387 |
| R Square | 0.165353232 | 0.135336715 |
| Adjusted R Square | 0.143388843 | 0.112582418 |
| Standard Error | 8.474848796 | 4.580709303 |
| Observations | 40 | 40 |

Table 4. The table shows the regression equation coefficients for male and female

| Measurements | Male | Female |
|---|---|---|
| Intercept | 78.11558978 | 98.81780175 |
| Fingerprint Length | 25.67021617 | 15.05756784 |

Table 5. The regression equation for stature estimation from fingerprint length of male and female

| Gender | Regression Equation | Standard Error |
|---|---|---|
| Male | Y = 25.67X + 78.11 | 8.474848796 |
| Female | Y = 15.05 + 98.81 | 4.580709303 |

X = Fingerprint Length, Y = Height

## COLLECTED SAMPLES

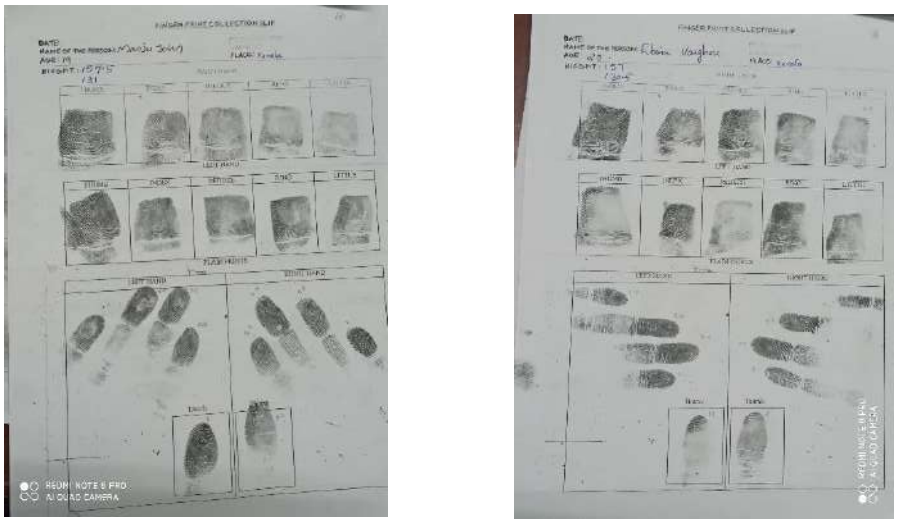

**Fig VI. Sample of female fingerprints**

**Fig VII. Sample of male fingerprints**

# CHAPTER - VI

# RESULT AND CONCLUSION

## RESULT

The data were analyzed using Karl Pearson's correlation coefficient (R) between various fingerprint lengths and stature was obtained.

Karl Pearson's correlation coefficient (R) values are found to be higher in males (0.406) when compared with females (0.367). The coefficient of determination (R2), the predictive accuracy, is found to be higher in males (0.165) than females (0.135) and all measurements are found to be positive. They are 84.13% statistically significant for stature estimation. The standard error is a measure of accuracy of predictions, which is found to be higher in males (8.474) and lower in females (4.580). The derived linear regression equations to estimate stature from finger print lengths in males show less reliable when compared with females.

Stature is found to be larger in males than females, showing the existence of a statistically significant sex difference in Keralites. This may be attributed to general male and female differences and natural size in both sexes and this finding is in accordance with the previous studies.

## CONCLUSION

The results of this investigation provided regression equations for stature determination from finger prints in Keralian population. According to the result the probability of estimating stature from fingerprint length is 84.13%. Even the presence of single finger print found in crime scenes is enough to estimate the stature for the purpose of inclusion and exclusion during the investigation process. It is erroneous to utilize these regression equations for stature determination to any other population either in Kerala or any other parts of the world.

# CHAPTER – VII

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