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# Study of Correlation between Hand Length and Foot Length in Human Beings

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## Abstract

**Background:** The dimensions and body proportions of human beings are widely variable with respect to age, sex and racial groups. All the parts of the body show biological variation. This fact can be utilized to predict the size of one part of the body using other part of the body. But there was no data available in the literature showing the relationship between hand length and foot length. Therefore present study was undertaken to determine the correlation between the hand length and foot length.

**Methodology:** Total 400 healthy and normal adult medical students (200 Male and 200 Female) between age group 18-25 years with no obvious deformities or previous history of trauma to the hands or feet were selected for the study. The hand length and foot length of both the sides of individuals were measured with the help of sliding calipers and spreading calipers respectively, and data was analyzed statistically for correlation.

**Results:** The correlation between hand lengths and foot lengths found to statistically highly significant on both sides in both sexes with p value < 0.0001. Correlation coefficients between hand lengths and foot lengths were higher for females than males.

**Conclusion:** It is therefore concluded that if the hand length is known, the foot length can be predicted and vice versa. This could be of help in medico-legal cases for the identification of body parts as well as in cosmetic surgery.

**Keywords:** Hand length, Foot length, Sliding callipers, Spreading callipers, Correlation.

## 1. Introduction

Dimensional relationship between body segments and the whole body has been the focus of scientists, anatomists and anthropologists for many years. Furthermore, the relationship between body segments has been used to compare and highlight variations between different ethnic groups and to relate them to locomotor patterns, energy expenditure, and lifestyle [1,2].

Human beings are considered to be bilaterally symmetrical. However, there is an asymmetry in the length of the feet irrespective of sex or handedness. Hand has been used as a tool for estimating the area of burn injury. The area of palmar surface of one's hand has been estimated to be 1% of the body surface area [3]. When hand length was compared with the bodyweight for both males and females

there were a curvilinear relationship which was not far from being linear [4]. The hand length has therefore been considered as an excellent predictor of body surface area and body mass. Change of foot length and width with age has been reported in a few anthropometric studies in literature [5]. The foot length and width were found to be increasing significantly on weight bearing between 3 and 18 years of age and in both genders [5,6].

There are many studies undertaken to emphasise the importance of the measuring the hand length as well as foot length. The relationship of hand length and foot length in relation to various body measurements was studied but the correlation between these two variables has not yet been studied. Hence the current study was undertaken to

determine the correlation between the hand length and foot length.

## 2. Material and Method

A cross sectional study was carried out on 400 healthy and normal adult medical students of either sex (200 Male and 200 Female), age between 18-25 years and those having no obvious deformities or previous history of trauma to the hands or feet were selected for the study. Permission was obtained from the Head of Departments of medical colleges to conduct this study. After getting approval letter from Independent Ethics Committee, the study was started. Exclusion criteria included students with any musculoskeletal deformity like kyphosis, scoliosis, poliomyelitis, trauma etc. which will affect the normal measurements of hand and foot length, measurements excluded if any nail extending over the end of toe and other fingers, patients with pedal deformity or injury, abnormal heights like gigantism, dwarfism etc.

After obtaining written informed consent the following measurements were taken from subjects: -

### 2.1 Hand Length:

It is the straight distance from mid-point of a line connecting the styloid processes of radius and ulna to the most anterior projection of the skin of the middle finger. The hand is laid flat on a table. It was measured with the help of sliding calipers (Figure 1), [7].

**Figure 1: Measurement of Hand length with the help of Sliding Caliper**



### 2.2 Foot Length:

It is the straight distance from the most posterior projecting point on the heel to the tip of the most anterior

projecting point of toe. With the subject standing erect, it was measured with the help of spreading calipers (Figure 2), [7]. Before measuring the foot lengths, it was ensured that both the feet were firmly placed on a flat surface and ensuring that both feet bears the body weight evenly. Footrest was used for ensuring flat surface. The length is measured between most backward and prominent part of the heel and the most distal part of the longest toe of the foot. Second toe was considered as most prominent while measuring the foot length; wherever it was longer than the great toe.

The measurements of hand length and foot length were taken from the limbs of both sides of the body. The measurements were taken in centimeters. The results were analyzed statistically.

**Figure 2: Measurement of Foot length with the help of Spreading Caliper**



### 2.3 Statistical Analysis

Statistical analyses were done using descriptive analytical methods which included Mean and Standard deviation, Pearson Correlation coefficient (r), students paired 't' test with and usage of graph pad software system.

## 3. Observations and Results

A total 400 healthy and normal adult medical students were included in the study among them 200 were males and 200 females. Table 1 shows the descriptive statistics of hand length and foot length in males and females whereas table 2 shows the descriptive statistics of parameters in total sample including males and females together.

**Table 1: Analysis of hand length and foot length in males and in females**

	Male Hand Length		Male Foot Length		Female Hand Length		Female Foot Length	
	Right	Left	Right	Left	Right	Left	Right	Left
Minimum	16.9	17.3	23	22	15.8	16	20.3	20.7
Maximum	21.5	21.6	29.2	29	20.2	20.3	25.9	26.3
Range	4.6	4.3	6.2	7	4.4	4.3	5.6	5.6
Mean	18.96	19.01	25.60	25.96	17.64	17.59	23.26	23.20
SD	1.189	1.091	1.335	1.327	0.834	0.874	1.179	1.167

**Table 2: Descriptive statistics of parameters studied in total sample including males and females together**

	Hand Length		Foot Length	
	Right	Left	Right	Left
Minimum	15.8	16	20.3	20.7
Maximum	21.5	21.6	29.2	29.0
Range	5.7	5.6	9.2	8.3
Mean	18.30	18.33	24.42	24.38
SD	1.219	1.239	1.717	1.716

The correlation between hand lengths and foot lengths were studied on both sides in males as well as in females. The correlation coefficients were determined by using Pearson correlation coefficient (r) (Table 3). The results showed a highly significant correlation ( $p < 0.0001$ )

between hand length and foot length on both sides in both sexes.

**Table 3: Correlation between hand length and foot length with Pearson correlation coefficient**

	Male (Hand Length)		Female (Hand Length)	
	Right	Left	Right	Left
Right Foot Length	0.69	0.66	0.73	0.72
Left Foot Length	0.71	0.67	0.74	0.73

When the values of the hand length and foot length were compared between the right and left sides using paired sample 't' test showed that the significant difference between males and females on both sides was highly significant for all the parameters measured with p value  $< 0.0001$  (Table 4).

**Table 4: Paired samples 't' test showing statistical difference between right and left sides of both sex as well as difference between males and females**

Statistical difference between right and left sides of males and females				
Paired samples		t	df	'P' value
Pair 1	Male LHL – Male RHL	2.988	199	$< 0.0001$
Pair 2	Male LFL – Male RFL	1.113	199	$< 0.0001$
Pair 3	Female LHL – Female RHL	2.331	199	$< 0.0001$
Pair 4	Female LFL – Female RFL	1.410	199	$< 0.0001$
Statistical difference between males and females				
Pair 1	Male LHL – Female LHL	15.395	198	$< 0.0001$
Pair 2	Male RHL – Female RHL	13.112	198	$< 0.0001$
Pair 3	Male LFL – Female LFL	19.577	198	$< 0.0001$
Pair 4	Male RFL – Female RFL	18.906	198	$< 0.0001$

#### 4. Discussion

Hand length and foot length has been studied extensively in relation to various body measurements but very few studies were available to predict the correlation between these two variables. Thus the present study was conducted to derive the correlation between hand length and foot length and the results demonstrate that there was highly significant correlation between them.

It is well established that bilateral symmetry exist in human population i.e. the difference between the measurements of the left and right side of the human body thus both the measurements was considered for the present study and results showed bilateral symmetry for all the parameters studied in males and females. The mean right hand length (RHL) and mean left hand length (LHL) for males were 18.96 and 19.01 which was higher than mean RHL and mean LHL for females i.e. 17.64 and 17.59. Also mean right foot length (RFL) and left foot length (LFL) were 25.60 and 25.96 of males which was higher than mean RFL 23.26 and mean LFL 23.20 of females. This finding correlates with different studies [8-11]. Thus the mean values of all male parameters studied were higher when compared with mean values of female parameters. These statistically significances between males and females were

due to the fact that fusion of epiphysis of bones occurs earlier in males than females. Males have about two more years of bone growth than females [12].

The correlation coefficients between right hand length (RHL) - right foot length (RFL) and left hand length (LHL) - left foot length (LFL) in males as 0.69 and 0.67 respectively also in females as 0.73 each. This indicates that there exist a highly significant correlation between hand length and foot length on both sides and in both males and females which was supported by correlation coefficients between hand lengths and foot lengths of Oomen Anita *et al* [13] and Danborn Barnabas *et al* [14]. When hand and foot were correlated the relationship between hand and foot length was higher in females than males as correlation coefficients between RHL-RFL were (males 0.69 and females 0.73) and LHL-LFL were (males 0.71 and females 0.74). This was similar to the results of Danborn Barnabas *et al* [14].

In the present study, all variables show statistically significant male-female differences at  $p < 0.001$  by student's t-test. Pearson's correlation analysis showed positive and statistically significant correlation between hand length and foot length. These depicts that the relationship between hand length and foot length was

significant. The data obtained was computed for providing a predicted range for hand dimensions so that if one variable is known the other can be predicted within the possible range. The range can predict hand dimension within the standard error of estimate thus can be used as a reference for future perspective in forensic domain.

## 5. Conclusion

The results of current study indicate that if the hand length is known, foot length can be predicted and if the foot length is known, hand length can be predicted and vice versa. From the data obtained, we have tried to establish a normal range for the hand length as well as foot length when one parameter is known. This can be of tremendous use in medico-legal cases especially in the identification of severed body parts. The data can also be of help in plastic and re-constructive surgery.

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