European Journal of Molecular & Clinical Medicine (EJMCM)
ISSN: 2515-8260 Volume 09, Issue 07, 2022

Original research article

To Evaluate the Reliability of Estimation of Height, Weight from Foot Length and Breadth.

[1]Dr Syeda Tasneem Kauser, [2]Dr Kannan Subramanian

[1]Assistant professor, Dept. of Anatomy, Mallareddy Institute of Medical Sciences, Hyd.

[2]Assistant professor, Dept. of Anatomy, Government Medical College, Karur

Corresponding Author: Dr Kannan Subramanian

Abstract

Introduction: Industrialization is a major breakthrough in development of any country, demanding maximum efficiency of work from people involved, this led to a separate branch of science called ergonomics and anthropometry being an integral part of it.

Materials & Methods: This study has done randomly with the students and faculty members in the age group of 18 years to 30 years. Sample size is 310, out of which 155 are males and 155 females. It was estimated considering the correlation, coefficient between foot length, breadth and height, weight of person (r = 0.869). The precision considered here was confidence interval as 95%, power as 90% and expecting the population co-relation as 0.92.

Results: The data was collected after the measurements of the foot were carried out and compiled in a tabular form. The compiled data was subjected to statistical analysis using Statistical package for social sciences .SPSS version and results obtained were analysed meticulously and the following observations were obtained. Multiple linear regression was used to find the independent predictors of height using length of right foot in sitting and standing position, length of left foot in sitting and standing position, breadth of right foot in sitting and standing position, and breadth of left foot in sitting and standing position.

Conclusion: Height estimation by measurement of various long bones has been attempted by several workers. However foot dimensions have not frequently been used for this. Ossification and maturation in foot occurs earlier than the long bones and therefore during adolescence age, height could be more accurately predicted from foot dimensions as compared to long bones.

Keywords: Height, Weight, Foot, Length

Introduction

Industrialization is a major breakthrough in development of any country, demanding maximum efficiency of work from people involved, this led to a separate branch of science called ergonomics and anthropometry being an integral part of it. 'Anthropometry' is a Greek word, anthros-man, metron-measure. It is the science that defines physical measures of a person's size, form and functional capacities .It has its implications in industrial design, ergonomics, architecture, forensic medicine, physiotherapy, orthopaedics, nutrition, evolutionary sciences, criminology, paediatrics and a vast ever expanding field with a wide spectrum of uses. Stature (standing height) is the maximum vertical distance from the surface on which the subject stands to the highest cranial point, the vertex, when head is held in Frankfurt plane[1]. Stature gives insight into the anthropometric characteristics of a population. Its estimation is considered to be an important assessment in the identification of unknown human remains[2, 3]Forensic studies have shown that the mature foot is not only unique to an individual, but also gives highly valuable clue regarding personal identity in a crime or

accident scene[4]. Growth, which is the vital process, is measured by measuring the height of a person, which itself is a sum of the length of certain long bones and appendages of the body represent certain relationship with form of proportions to the total stature. Population based differences exist in both metric and morphological features of the skeleton and these have changed over the time. Therefore, it is vital for biological anthropologists to conduct up-to-date research on diverse population groups residing in different geographic zones. Height estimation by measurement of various long bones has been attempted by several workers. However foot dimensions have not frequently been used for this. Ossification and maturation in foot occurs earlier than the long bones and therefore during adolescence age, height could be more accurately predicted from foot dimensions as compared to long bones.

MATERIALS AND METHODS:

This study has done randomly with the students and faculty members in the age group of 18 years to 30 years Materials used:

Materials used for the present study are:

- Osteometric board
- Digital weighing machine
- Standiometer
- Sliding vernier caliper

EXCLUSION CRITERIA:

Subjects below 17 years and above 31 years, those with skeletal abnormalities of axial skeleton, lower extremities and pathological conditions with regard to foot.

SAMPLE SIZE:

Sample size is 310, out of which 155 are males and 155 females. It was estimated considering the co-relation co-efficient between foot length, breadth and height, weight of person (r = 0.869). The precision considered here was confidence interval as 95%, power as 90% and expecting the population co-relation as 0.92.

Results:

The data was collected after the measurements of the foot were carried out and compiled in a tabular form.The compiled data was subjected to statistical analysis using Statistical package for social sciences (SPSS), version……. and results obtained were analysed meticulously and the following observations were obtained. Multiple linear regression was used to find the independent predictors of height using length of right foot in sitting and standing position, length of left foot in sitting and standing position, breadth of right foot in sitting and standing position, and breadth of left foot in sitting and standing position.

HEIGHT:

It was found that in males 68 percentage of the variation in height can be predicted using the foot length and breadth factors. In females 54 percentage of the variation can be predicted using foot length and breadth parameters.

In males length of the right foot in standing position, breadth of the right foot in standing position and breadth of the left foot in standing position was found to be the most correlated parameters with the height of a person. In females length of the left foot in standing position was found to be the most correlated parameter with the height. These parameters can be used to predict height of a person by deriving a regression formula for the same.

WEIGHT:

With respect to weight, in males 59 percentage of variation in weight can be predicted using the foot length and breadth parameters. In females 57 percentage of variation in weight can be predicted using the foot length and breadth parameters.

The predictors and parameters strongly correlating with respect to weight in case of males are – length of left foot in sitting position ,breadth of left foot in sitting position, breadth of left foot in standing position.
The predictors and parameters strongly correlating with respect to weight in case of females are – length of right foot in standing position ,length of right foot in sitting position, breadth of right foot in standing position and breadth of right foot in sitting position.
Position :
Difference in foot length and breadth in standing and sitting position was obtained indicating the effect of height and weight on the arches of foot.

CORRELATION COEFFICIENT:

Males :

Parameter	Right foot length ,sitting	Right foot length ,standing	Left foot length ,sitting	Left foot length ,standing	Right foot breadth ,sitting	Right foot breadth ,standing	left foot breadth,sitting	Left foot breadth ,standing
Height	0.622	**0.632**	0.619	0.624	0.485	0.499	0.484	0.510
weight	0.436	0.457	0.433	0.448	0.449	0.495	0.455	**0.511**

In males ,the height is most significantly correlated with right foot length in standing position (0.632) and weight is most significantly correlated with left foot breadth in standing position (0.511).

Females :

parameter	Right foot length, sitting	Right foot length standing	Left foot length sitting	Left foot length ,standing	Right foot breadth sitting	Right foot breadth standing	Left foot breadth sitting	Left foot breadth standing
Height	0.523	0.525	0.528	**0.543**	0.019	0.054	0.026	-0.039
Weight	0.286	**0.343**	0.277	0.333	0.220	0.288	0.208	0.121

In females the height is most significantly correlated with left foot length in standing position (0.543) and weight is most significantly correlated with right foot length in standing position (0.343).
Correlation coefficient between foot length and foot breadth:

Males :

Parameter	RFB(sitting)	RFB(standing)	LFB(sitting)	LFB(standing)
RFL(sitting)	0.410	0.445	0.381	0.421
RFL(standing)	0.441	**0.488**	0.413	0.462
LFL(sitting)	0.398	0.439	0.375	0.414
LFL(standing)	0.439	0.487	0.413	0.458

RFL – right foot length, RFB – right foot breadth, LFL—left foot length, LFB—left foot breadth.
Highest significant correlation is found between right foot length in standing position and right foot breadth in standing position(0.488) as compared to other parameters.

Females :

Parameter	RFB(sitting)	RFB(standing)	LFB(sitting)	LFB(standing)
RFL(sitting)	0.014	0.046	0.010	-0.110
RFL(standing)	0.062	0.101	0.057	-0.088
LFL(sitting)	0.039	0.071	0.037	-0.151
LFL(standing)	0.093	0.133	0.093	-0.122

RFL – right foot length ,RFB—right foot breadth, LFL – left foot length, LFB – left foot breadth.

No significant correlation coefficient was found between foot length and foot breadth in case of females.

MEAN AND STANDARD DEVIATION VALUES:

Group Statistics

	sex	Mean	Std. Deviation	P value
age	MALE	20.78	1.85	0.157
	FEMALE	20.46	2.15	
height (cm)	MALE	173.31	7.41	<0.01
	FEMALE	160.26	7.07	
weight(kg)	MALE	66.28	8.94	<0.01
	FEMALE	54.74	7.75	
length right foot (sitting)	MALE	26.05	1.00	<0.01
	FEMALE	23.73	1.10	
length right foot (standing)	MALE	26.35	1.01	<0.01
	FEMALE	23.95	1.10	
length left foot (sitting)	MALE	26.03	1.02	<0.01
	FEMALE	23.74	1.09	
length left foot (standing)	MALE	26.31	1.03	<0.01
	FEMALE	23.95	1.06	
breadth right foot (sitting)	MALE	7.05	0.71	<0.01
	FEMALE	5.92	0.75	
breadth right foot(standing)	MALE	7.40	0.74	<0.01
	FEMALE	6.16	0.76	
breadth left foot (sitting)	MALE	7.02	0.72	<0.01
	FEMALE	5.88	0.77	
breadth left foot (standing)	MALE	7.34	0.74	0.021
	FEMALE	6.47	4.56	

Discussion

Relationship between foot length, foot circumference, height and weight was calculated in the age group of 17 years to 25 years in Turkey and it was observed that the co-relation between foot length and height was more significant than the co-relation between foot length and weight of the individual [5].The reliability of prediction of height from foot length was as high as that from long bones, was observed in study by various workers[6,7]. A study to determine the relationship between hand length and foot length was carried out involving 100 normal subjects (50 males and 50 females) between the ages of 19-25 years with no obvious deformative or previous history of trauma to the hands or feet. Their hand length and

foot length were measured using the standard points and data was analysed statistically for co-relation. The results showed a significant co-relation between hand length and foot length. Hence it was concluded that if hand length is known the foot length can be calculated[8] . The foot anthropometric morphology phenomena are analysed together with hidden biomechanical functionality in order to fully characterize foot structure and function. Measurements were done on 103 adult normal Croatian students. Results showed the influence of various life style factors influencing the foot morphology and function and the study of foot structure by 3D computerized methods are of more use than conventional methods and it has its implications in sports and ergonomics[9] .Estimation of stature on the basis of lower limb measurements of femur length, tibial length, fibular length ,foot length and foot breadth was carried on 503 male shia , muslims of Delhi in the age range of 20 years -40 years. Results revealed that foot breadth exhibits the lowest value of standard deviation, while the highest value was observed for femur length and that foot breadth can be used for stature estimation in the absence of other parameters[10]. A relationship between stature and foot dimensions among. Rajbansi male and female individuals of North Bengal was established by examining 350 adults in the age group of 18-50 years .The results indicated that the females had shorter stature and smaller feet than their male counterparts. there were significant differences in stature, foot length and foot breadth between sexes. bilateral variation was significant within sexes with respect to foot length ,but not with foot breadth. Stature , foot length and foot breadth are positively and significantly correlated with each other .The higher correlation coefficient between stature and foot length over that of stature and foot breadth points to the fact that foot length, rather than foot breadth, is more accurate in estimating stature. Using linear regression, it was, observed that stature was strongly dependent on foot length and foot breadth and Foot breadth is strongly dependent on foot length and that prediction of stature is more accurate by using step-wise multiple regression[11] .Gayer was the first person to conduct a detailed study of foot prints and published his results. It was also observed that the co-relation of foot length, foot outlines and the stature gave a better prediction of height than other measurements [12] .Studies regarding Stature estimation from various long and short bones of the body were also carried out and was found of immense use in forensic science and criminology[13] .Correlation of foot length with height and weight in school age children was evaluated in Greece involving 5093 children in age group of 11 years-13 years, over a period of 10 years. Statistical analysis included uni variaent and multivariate linear regression models which indicated significant correlation between the parameters and it was suggested that foot length can estimate the stature and weight of a juvenile, especially after adjusting for age and sex[14] .Anthropological study of the foot and it's relationship between different parameters and stature in an adult population of different areas of Gujarat was carried out in 285, a symptomatic healthy adults (149 males and 136 females) in the age group of 18 years-23 years belonging to different regions of Gujarat. After statistical analyses of the obtained data, linear regression equations were derived to calculate foot length and stature from foot breadth with strong co-relationship between the parameters[15].There was another study aimed to analyse, the correlation between foot length and height in Mumbai population. It was done on 298 individuals residing in Mumbai. The subjects were divided into 6 groups according to the height and foot length and each subject was assessed. The average of mean foot length in males and females in all age groups from 11 years -30 years (and more) is 20.80 cm and 20.81 cm respectively. The co-relation co-efficient between height and length of foot also showed significant association for all age group and sex. The authors concluded that height of an individual either male/female is 6.5 times the length of his/her foot length[16].Stature estimation from foot dimensions was also conducted in Nigerian population .The purpose of this study was to establish the reliability of estimating stature ,from the foot dimension of an adult Nigerian

population.Three hundred subjects out of which 170 were males and 130 were females,of Igbo descent and aged between 18 and 30 years.Anthropometric measurements taken included stature,foot length,foot breadth and foot circumference.results showed that the mean values of foot length ,foot breadth and foot circumference for the sample size were 26.41±1.89 cm,10.19±0.79 cm and 62.62±3.75cm respectively. A positive correlation coefficient was observed between foot dimensions measured and stature in both sexes [17].The study conducted by Mansur et al was to establish a regression equation and correlation coefficient between a person's height and mean foot length with 440 healthy asymptomatic students in the age group 17 years -25 years studying in Kathmandu university school of medical sciences, Dhulikhel, Nepal. results indicated significant correlation between height and foot length .the regression equation for height and foot length was found to be Y=3.179X + 87.65 where X is the foot length and Y the height of the individual [18].A.I.Shugaba et al carried out the observations to estimate the relationship between foot length ,foot breadth,ball girth,height and weight of school children aged between 3 and 5 years ,to know the extent of the development and factors that influence their development and how these parameters can be used in anthropometric studies .200 children of both sexes were sampled using simple random sampling technique.the parameters were measured using standard anthropometric instruments.Pearson coefficient showed the relationship between the various parameters measured ,multiple comparisions were also used to find the mean difference between the age groups in which the variation in age groups and sex differences were studied [19].There are numerous means to establish stature and its significance lies in the applicability and accuracy in prediction.A regression equation was developed for stature estimation from foot length and a significant correlation between body height and foot length was established in Andhra population[20].

Conclusion

Height estimation by measurement of various long bones has been attempted by several workers. However foot dimensions have not frequently been used for this. Ossification and maturation in foot occurs earlier than the long bones and therefore during adolescence age, height could be more accurately predicted from foot dimensions as compared to long bones. Present study is therefore conducted to find out co-relation between foot length, breadth and body height, weight and evaluate the reliability of estimation of height and weight from foot length, breadth in students and faculty members between the age group of 19 years to 30 years.

References:

1. Anthropology at war: world war 1 and the science of race in Germany page 90,by Andrew D Evans.
2. Trotter M, Glesser GC .Estimation of stature from long bones of American and Negroes . American Journal. Of Physical Anthropology 1952;10(4):463-514.
3. Margaret Anderson, Marie Blais and William T Green, Growth of the normal foot during childhood and adolescence. Length of the foot and interrelations of foot ,stature and lower extremity as seen in serial records of children between 1-18 years of age, American Journal of Physical Anthropology, June 1956;14(2):287-308 .
4. Rutishauser. Prediction of Height from Foot Length: Use of Measurement in field surveys. Arch dis childhood 1968;43:310.
5. Aml, Peker T, Turgut HB, Ulukent SC. An examination of the relationship between foot length, foot breadth, ball girth, height and weight of Turkish university students aged between 17 and 25. Anthropologischer Anzeiger Jahrg. 1997; 55: 79-87.

6. Kulthanan T,Techakampuch,Bed ND.A study of foot prints in athletes and non – athletic people,J med association Thai 2004;87:788-793.
7. Ozden H,Balci Y,Demirustu C, et al,Stature and sex estimate using foot and shoe dimensions.Forensic scientific international 2005;147:181-184.
8. Anitha Oommen, Avinash Mainker and Tom Oomen,A study of the co-relation between hand and foot length in humans, journal of anatomical society of India 2005 ;54 (2):1-9.
9. Ante Agic,Vasilije Nikolic,and Budimir Mijovic,Foot Anthropometry and morphology phemenon;coll.antropol,2006;30(4):815-821.
10. Bhavna and Surinder Nath,Estimation of stature on the basis of measurements of the lower limb,Anthropology today:trends ,scope and applications, 2007;Anthropologist special volume no.3:219-222.
11. Jaydip Sen,Shila Ghosh, Estimation of stature from foot length and foot breadth among the Rajbanshi:An indigenous population of north Bengal, Forensic science international ,2008;181(1-3):55.e1-55.e6.
12. Kewal Krishan. Estimation of stature from footprint and foot outline dimensions in Gujjars of North IndiaForensic Science International 2008;175: 93–101.
13. Manisha R.Dayal,Maryna Steyn and Kevin L.Kuykendall,Stature estimation from bones of South African Whites,South African Journal of science 104,March/April 2008:124-128.
14. Theodoros B Grivas,Constantinos Mihas, Angeliki Arapaki,Elias Vasiliadis,Correlation of foot length with height and weight in school age children,Journal of Forensic and legal Medicine ,2008;15:89-95.
15. Dr.Shailesh M.Patel,Dr.Vikash Doshi,Dr.Srushti Ruparelia,Dr. Ankur Zalawadia,Dr. Dhara Parekh, Dr.S.P.Rathod,Dr.Akruti Parmar,Anthropological study of the foot and it's relationship between different parameters and stature in an adult population of different areas of Gujarat,2011;vol 2(3):67-70
16. Dr .Pradeep .K.Pawar,Dr.Abhilasha Dadhich,Study of co-relation between human height and foot length in residents of Mumbai,International journal of biological and medical research2012;3(3):2232-2235
17. Egwu O A,Nto NJ,Bello EF,Egwu EO,Ukoha UU,Ajah D,Stature estimation from foot dimensions of an adult Nigerian Population,Anatomica Karnataka 2012;6(2):8-12 .
18. Mansur DI, Haque MK, Sharma K, Karki RK, Khanal K, Karna R. Estimation of Stature from Foot Length in Adult Nepalese Population and its Clinical Relevance. Kathmandu Univ Med J 2012;37(1):16-9.
19. A.I.Shugaba,F.Shinku,I.M Gambo,M.B.Mohammed,et al,Relationship between foot length ,foot breadth,ball girth,height and weight of school children aged 3-5 years old,Journal of biological and chemical research,2013;30(1):107-114.
20. Anil Rambhauji Sherke, DW Tamgire, Correlations of stature with foot length in Andhra region,International Journal of Biomedical research,2013;4(9):494-498.