ORIGINAL ARTICLE

CORRELATION BETWEEN HEIGHT AND HAND SIZE, AND PREDICTING HEIGHT ON THE BASIS OF AGE, GENDER AND HAND SIZE

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ABSTRACT

Objective: To find out the correlation between hand size and height, as well as to formulate a regression equation for predicting height on the basis of age, hand size and gender.

Material and Methods: This correlational study was conducted in the Physiology Department of Khyber Medical College from 1stJanuary to 20th April 2017. It is based on 194 students of 2nd Year MBBS. The subjects were randomly allocated into a devising/developmental group and a cross validation group. A formula was devised from the developmental group, using linear regression analysis to find out predicted height (PH). It was tested on the cross validation group.

Results: The average male height was 173.7cm and hand length was 18.85 cm. Female height was recorded as164.6cm and hand length as 17cm. The correlation between hand length and height came out to be positive, $p<0.001$ in both genders. The formula derived is: Height cm = 176.81848 - 2.77758 * age (years) + 2.33909 * hand size(cm) +6.11263 * gender (gender: women=0, men=1). The difference in the means of actual heights and the predicted heights was 2.9cm.

Conclusion: The formula devised to predict height from hand length; gender and age can validly predict height up to an accuracy of 2.9 cm. This can also be used in clinical setup wherever height prediction is required.

Key Words: Body Height, Regression Analysis, anthropometry, Hand size.

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INTRODUCTION

From the Golden ratio to the Vitruvian man drawn by Leonardo da Vincito the recent advances in research, man has been trying to find symmetry in the works of God.[1] If there is symmetry in a structure, one can predict the morphometry of one of its parts based on the dimensions of the other.[2] Leonardo clearly illustrates in Vitruvius' De architectura 3.1.2-3, which reads:

"For the human body is so designed by nature that the face, from the chin to the top of the forehead and the lowest roots of the hair, is a tenth part of the whole height; the open hand from the wrist to the tip of the middle finger is just the same; the head from the chin to the crown is an eighth, and with the neck and shoulder from the top of the breast to the lowest roots of the hair is a sixth."[1]

According to the oxford dictionary, height is the measurement of a person from head to foot.[3] Height and stature are synonyms so both these words are used interchangeably to describe vertical length of a person.[3] One of the methods of quantifying growth is height, which is very important especially in kids and adolescents.[4] Those children with short stature and receiving growth hormone therapy also need it for therapy monitoring. The dimensions of various body segments have been used to predict height.[5]

Height prediction is also important in medico-legal cases such as victim identification.[6] Height determination from the size of a body part such as hand is important for forensic purposes.[4] This is most applicable to the victims of bomb blast injury and to find out racial differences.[4]

The differences between various ethnicities based on height measurement, which led to diverse locomotive

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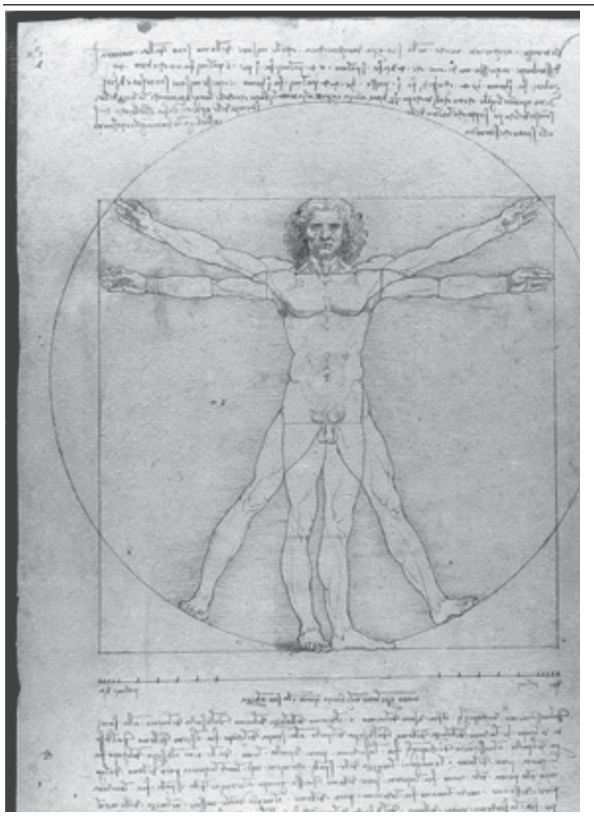

Figure 1: Vitruvian man drawn by Leonardo da Vinci (Courtesy Wikipedia)

patterns and body mass index have also been studied and quantified worldwide.[6] Body is made naturally symmetrical and the proportions of various body parts have a relation with one another. The arm span of a person is equal to his height.[7] A study conducted in Mumbai showed that height is 9.03 to 9.08 times greater than hand length.[4]

For bedridden patients or individuals with any other conditions limiting their ability to stand, it may be necessary to resort to alternative anthropometrical indicators to estimate their height.[8] Out of these alternatives, Cockram DB found a strong correlation between stature and knee height, R2 of 0.83. He used calipers which is time consuming method and rather technical too.[8] Peters DM mentions that ankle breadth and hand length may predict frame size more accurately in young men than other bone dimensions.[9] An Iran based study showed a positive correlation between height and upper limb measurements such as hand-size, forearm and arm length.[10]

Stature is affected by genetics, environment, puberty onset, activity level and type and nutritional factors.[11] Stature can be used for personal identification, moreover it can describe certain characteristics of a population such as nutritional status and genetics.[12] The three commonly used algorithms for height prediction were identified by Topor LS and these are Bayley-Pinneau (BP), Roche-Wainer-Thissen (RWT), and Khamis-Roche (KR).[13,14]

Where ever, prediction of a dependent variable is needed, there comes the role of regression analysis. Habib SR predicted stature from hand and phalanges length in an Egypt based study, using a linear regression model.[15] Jee SC derived multiple regression equations for height prediction and found that hand length was the most accurate predictor of stature.[16]

The aim of this study is to find the correlation between hand length and height. It also aims to formulate a regression equation for predicting height and then cross validate it for measuring its effectiveness. Various studies have been carried out in Caucasians but hardly a few exist representing this part of the world.[17,18]

MATERIAL AND METHODS

This is a co-relational study conducted in Physiology Department, Khyber Medical College, Peshawar, Pakistan. Total 194 students of Second Year MBBS were included. The age of the study participants ranged from 18-21 years. Those students with hand deformity or trauma were excluded. The dependent variable is height and the independent variables are hand size, age and gender. The research was approved by the ethical review committee of Khyber Medical College.

A centimeter ruler with accurate measurement up-to 1 mm was used to note down their hand size. The measurements were taken with the aid of pre-trained lab technicians. Hand length was taken as the linear distance from the tip of middle finger (dactylion) to the first wrist crease next to the palm (midstylion line). The palm faced upwards and the fingers were extended and adducted during measurement. The right hand was selected for measurements. The height was the measurement between the vertex and the floor when the person was standing erect with shoes off. For height measurement, a standard stadiometer was used to measure the subjects' height.[15,16,19] Informed consent was taken from all the study participants.

Descriptive statistics were calculated using SPSS-20 and pearson correlation test was applied to find out the correlation between hand size and height. The subjects were then randomly allocated into two groups, the devising/developmental group (n=130) and the cross validation group (n=64). The devising sample was used to derive the regression equation and the cross validation sample was used to check its effectiveness in predicting height by comparing actual height (AH) with predicted height (PH). The software StatPlus:mac LE was used for deriving the equation. The difference was calculated between actual and predicted height and its mean was determined for both males and females. References were managed using Mendeley version1.17.8.

RESULTS

The study population constituted both male and female students of 2nd year MBBS of Khyber Medical College, out of which 86(44.3%) were females and 108 (55.7%) were males (n=194). Average height of female students was 5'4" (164.6 cm) and those of male students, was 5'7" (173.7 cm). The average hand length in females was 17cm. In males, it was 18.85cm. A scatter-plot of height and hand size show a positive linear relationship between the two. The Pearson correlation shows a moderately positive correlation of 0.512 between height and hand size with $p<0.001$. The proposed regression equation developed for height (cm) is:

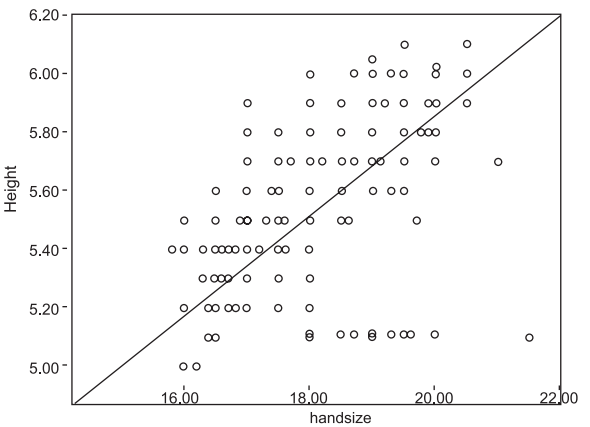

Figure 2: Scatter plot showing relation between height and hand size

Height cm = 176.81848 - 2.77758 * age (years) + 2.33909 * hand size (cm)+ 6.11263 * gender (gender: women=0, men=1). Sex and hand length are significant predictors of height ($p<0.001$) whereas the rest have a relation with height but are not good predictors. When the formula was applied to predict heights in the cross validation sample, their means were calculated. The difference in the means of actual height and the predicted height was 2.9cm.

DISCUSSION

The study showed a difference between height and hand length of males and females. The values for males were higher than for females. The scatter plot with height on the Y-axis and hand size on the X-axis showed a positive linear relationship. The pearson correlation between height and hand size showed a correlation of 0.512 which according to Cohen' convention for effect size, is strong, with $p<0.001$, which is highly significant.[20] The formula devised on basis of regression was applied to the cross validation sample. The predicted heights were close to the original ones. When difference was calculated between means of the actual heights and the predicted ones it was found to be small.

Gender and hand length came out to be good predictors of height whereas age is a poor predictor. Gender is a good predictor as it's a known fact that on average males are taller than females because of their delayed growth spurt onset thus adding a few more growing years to their development.[21] According to a study conducted in Turkey, gender is the best regressor for height prediction with an $R2=0.861$.[22] Subjects' chosen were young adults, which means they were out of their growing age and had achieved their final adult height. Thus, making age a poor predictor of height in adult hood, as a 20 year old woman can be both 4 feet tall and 6 feet tall.

Marcus Vitruvius Polliono (BC) was the first to give the relation between stature and hand length. This concept, was then, taken up by Leonardo da Vinci.[23] Since then numerous studies have been conducted to relate hand length with stature. According to a study, symmetry in various body parts depends upon their rates of development with respect to one another during fetal life. Moreover, some animals including humans are regarded as bilaterally and radially symmetrical.[24] So the question that whether to exclude left handed persons or not, becomes unimportant. Moreover, young adults were included in the study as with increasing age, a narrowing of the spinal discs and a decrease of the spine length occurs, subsequently effecting the height.[25]

Different techniques have been adopted to predict height, which include arm span, half-span, knee height, ulna length or hand-length.[19] Its easy and more accessible to measure hand and it requires minimum range of movement by the patient.[19] Hence, hand was chosen as the parameter of choice as it can be measured most conveniently and requires, a segmometer, or an anthropometrical tape or simply a centimeter ruler and just one technician.[19] Other measurements, such as half span and ulnar length, would require two technicians per subject.[4]

RECOMMENDATIONS

This study can be generalized upon the young adult population of Khyber Pakhtunkhwa and in order for this formula to be valid for the whole adult population of Khyber Pakhtunkhwa, more similar studies need to be conducted with a diverse sample including all age groups.

The main limitation of this study is that it didn't take any other measurement such as half-span or ulnar length to fortify the results. This was due to lack of technical staff and lack of time, which the subjects could spare for the study.

CONCLUSION

There is a positive relationship between hand length and height. The formula developed in this study

is good up to 2.9cm with gender being the best predictor of height followed by hand size and then age.

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AUTHOR'S CONTRIBUTION

Following authors have made substantial contributions to the manuscript as under:

Zafar U: Concept and design, data collection literature.
Rahman Su: Data analysis manuscript writing.
Hamid N: Literature review and statistical.
Ahsan J: Compiling reviewing.
Zafar N: Manuscript drafting.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.