KNEE HEIGHT-PROXY INDICATOR OF BODY HEIGHT IN SUBJECTS OF NORTH INDIA

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ABSTRACT

Body Height decreases with age almost entirely because of shrinkage of the vertebral column and osteoporosis; therefore, an alternative means to study body height that were independent of age were found as "Surrogate Methods" or "Proxy Indicators " of body height.This study was conducted to correlate Knee Height with Body height and to compute linear regression equations to estimate body height according to gender including age as a predictor variable in order to reduce the inherent problem of sample specificity and enhance accuracy confidence in the estimation.

This exploratory study was conducted on asymptomatic, healthy 1000 subjects (500 males and 500 females), residents of Teerthanker Mahaveer University of cosmopolitan origin age over 18 years old with no diagnosed history of knee arthropathy and spinal deformity. Their body height and knee height were measured and all the readings were subjected to Statistical Analysis using mean± standard deviation, Pearson's correlation coefficients and linear regression analyses.In present study, knee height was found to be statistically significant and positive with body height. Regression equations for estimating body height were developed according to gender including age as a predictor variable in order to reduce the inherent problem of sample specificity and enhance accuracy confidence in the estimation.

Key words:-*Body height1, Proxy Indicator2, Knee height3, Correlation Coefficient4, Linear Regression Analysis5, Surrogate methods6.*

INTRODUCTION

Body Height is considered one of the vital of the "Big Four" parameters within the biological profile of identification and indeed used as an important indicator of body composition.Identification is a part and parcel of forensic experts in all medico-legal cases as Identity is the birth right of every individual.

As in current scenario, body composition research is provoking issue with the advent of Bio-Impedance Analysis (BIA); more emphasis is laid on comparison of body composition between subjects of different ages and populations. Shrinkage of the vertebral column, osteoporosis and various physical anomalies such as fractures, amputations, paralysis etc. may cause excessive loss of height in some study participants leading to biased results in body composition studies. [1, 2, 3, 4]

Many researchers have stated that there may be certain degree of independence between age and knee height. [5]

The loss of height which occurs in the elderly results in difficulties in applying many equations based on estimates from adult population. The accuracy of the equation is reduced if used to estimate stature in population in which the equation has not being derived from.[6]Therefore, there is a need to develop equations to estimate body height in both adults and older age group for used in the research of anthropometric, forensic science as well as nutrition and health as a need for cohort study of knee height measurements from the early adulthood through to the later years of life to verify its age independent characteristics.

Chumlea et al[7, 8]showed that the knee height is a surrogate for height in the elderly and proposed it as an alternative to measuring height in bedridden people , they used a Nomogram to convert knee height with a precision of ± 6.0cms (90% confidence limits).

Knee height, recognized by the World Health Organization has being increasingly used as a recumbent measurement to predict stature is not sensitive to age related shrinkage.

No study till now in India validated recumbent height measurements against standing height measurements among adults or elderly individuals without any ambulatory or debilitated conditions that cause inaccuracy of the measurements. Regression analysis is usually performed to develop simple predictive equations to predict stature according to gender using age as predictor variable.

Therefore present study aimed to predict the Knee Height as best body height indicator and to develop a nationally representative prediction equation for estimation of stature according to gender including age as a predictor variable in order to reduce the inherent problem of sample specificity and enhance accuracy confidence in the estimation.

MATERIAL & METHOD

For present study, total 1000(500 males and 500 females) asymptomatic, healthy adults age over 18 years old with no diagnosed history of knee arthropathy and spinal deformity and a written informed consent will be taken from the subjects. The measurements will be taken between 2 to 5 p.m. to eliminate the discrepancies due to diurnal variations.No Objection Certificate was obtained from the college Ethical Research Committee.

Sampling Method:-Purposive sampling methodas this method is best when we are studying a particular set of groups.

Study design: Analytical study.

Body Height (B. H.) will be measured with an anthropometer/Stadiometer and will be taken from the vertex to the floor with the person standing barefoot in the anatomic position and with the head in Frankfurt plane in centimeters.

Knee Height (K H) defined as the distance from the heel of the foot to the top of the patella, (most anterior surface the femoral condyles of the thigh, medial being more anterior), with the ankle and knee each flexed to a 900 angle. The recumbent measurement of knee height will be obtained in accordance with instructions for use of Ross knee height calipers with a modified horizontal fixed blade, recorded in centimeters.

Fig. 1 Knee Height measurement

One blade of the sliding broad-blade caliper will be placed under the heel of the right foot. The heel rests on the calipersblade; this will be best accomplished by resting the foot in the palm of the examiner's hand to maintain a 90º angle at the ankle.

The other blade will be placed over the anterior surface of the right thigh, across the condyles of the femur and just proximal to the kneecap. Pressure will be applied to completely compress tissue or to the maximum comfortable pressure. Knee height will be recorded to the nearest 1 mm.All the readings were tabulated & subjected to statistical analysis using mean ± standard deviation of data and computing the correlation coefficient(-1 to +1) with excel on window professional 2007. Associations were considered statistically significant at the<0.01 level evaluated with Z-test. Derivation of Linear regression equations was done to calculate height from knee height of an individual. All measurements were recorded by the same person in order to avoid interobserver bias employed.

Standardized anthropometric instruments used in all studies, yet there is lack of uniformity between methods and the degree of measurement error associated. This is significant because high amounts of measurement error can invalidate statistical results. Targets for anthropometric assessment have been put forward by Zerfas,[9] using a repeat- measures protocol. In present study, intraobserver precision estimates for measures of body height, foot lengths & Knee height measurements were evaluated from two repeated measures on 50 subjects and then mean of two was taken. From this replicate data, three precision estimates were calculated: the technical error of measurement (TEM), the relative technical error of measurement (rTEM), and the coefficient of reliability (R),[9] or reliability analysis.

Technical error of measurement (TEM) is a measure of error variability that carries the same measurement units as the variable measured. Its interpretation is that differences between replicate measurements will be within± the value of TEM two-thirds of the time.[10] Similarly, 95% of the differences between replicate measurements are expected to be within±/2_/TEM,[11] which is referred to as the 95% precision margin. Intra-observer TEM is estimated from differences between replicate measurements taken by one observer, while interobserver TEM is estimated from single measurements taken by two or more observers. From TEM, the coefficient of reliability(R) can be determined, which ranges from 0 (not reliable) to 1 (complete reliability) although there are no recommended values for R, Ulijaszek and Kerr (1999)[12]suggested that a cut-off of 0.95 be used (i.e. a human measurement error of up to 5%). So a reduction in error indicates improvement in measurement technique between observers, and greater quality control.

RESULTS AND OBSERVATIONS

Table 1:- Mean± Standard values of Body Height and Knee Height in both Males and Females

	MALE	FEMALE
BODY HEIGHT	168.14±7.708	157.68±7.068
KNEE HEIGHT	51.6±3.21	47.7±2.26

Table 2:- Correlation coefficient, Slope and Constant Values of Body height and Knee heightin both males and females

PARAMETERS	MALE	FEMALE
CORRELATION COEFFICIENT (r)HEIGHT & KNEE LENGTH	0.7477**	0.5111**
REGRESSION COEFFICIENT(b)	1.792	1.797

VALUE OF CONSTANT(a)	75.62	71.92

**Strongly Significant as p-value < 0.01

Table 3:-Linear Regression Formulae for Body Height (cms) from Knee Height

SEX	VARIABLES	EQUATIONS	S.E.E. (cms)	COEFFICIENT OF DETERMINATION (R^2)	ADJUSTED (R^2)	P Value
Males	KNEE HEIGHT	B.H.=75.62+1.79(KH)	0.12	0.54	0.01	<0.01
	KNEE HEIGHT WITH AGE	**B.H.=80.62+1.79(KH)-0.18(AGE)**	0.45	0.6	0.20	<0.01
Females	KNEE HEIGHT	B.H.=71.92+1.79(KH)	0.37	0.26	0.13	<0.01
	KNEE HEIGHT WITH AGE	**B.H.=72+1.79(KH)-0.0002(AGE)**	0.31	0.3	0.09	<0.01

P<0.001, strongly significant

The technical error of measurement (TEM) can be determined which is an accuracy index and measures the standard deviation between repeated measures. The formulation of TEM depends on how many observers have taken the measurement. If the same observers has measured on two occasions (a measure of intra-TEM) or two observers have measured the same, then the formula for TEM is where D is the difference between the two measurements, and N is the sample size, as shown in Table 4.

$$\sqrt{\frac{\sum D^2}{2N}}$$

It is also possible to compute the relative TEM (%TEM), which provides an estimate of the error magnitude relative to the size of the measurement (expressed as a percentage) and is analogous to the coefficient of variation (see below).

$$\%TEM = \frac{TEM}{\bar{X}} * 100$$

From TEM, the coefficient of reliability (R) can be determined, which ranges from 0 (not reliable) to 1 (complete reliability), where SD is the standard deviation of all measurements.

$$1 - \left(\frac{(TEM)^2}{SD^2} \right)$$

Table 4: Three precision estimates of reliability as TEM, rTEM and R for different

Parameters	**TEM (cm)**	**rTEM (%)**	**R**
Body Height	< 0.5	< 0.84	> 0.98
Knee Height	< 0.5	< 0.84	> 0.98

DISCUSSION

The measurement of Body height is either not possible or accurate in situations where patients cannot assume the posture necessary for the accurate measurement. Knee height is the commonest used anthropometric variable used in above circumstances as proxy indicator to standing height. Moreover it is independent of age and does not appear to decrease over time and has an additional advantage as it could be measured also while patient is seated or lying down.

In the present study Correlation Coefficient between body height and knee height is 0.7477 in males and 0.5111in females, suggesting knee height statistically significant and positive with body height. Linear Regression Formulae computed as–B.H.=75.62+1.79(KH); R^2=0.54 in males andB.H.=71.92+1.79(KH);R^2=0.26

B.H.=80.62+1.79(KH)-0.18(AGE) in males ;$R^2 = 0.6$and B.H.=72+1.79(KH)-0.0002(AGE) in females; R^2=0.3.The inclusion of age as predictor variable into the equation between body height and knee height improved the value of R^2

There are many equations for estimating body height from knee height reported by many workers in various countries but in Japan, the equations by Miyazawa[13] as
Men Y=64.02+2.12×KH-0.07×age
Women Y=77.88+1.77×KH-0.10×age and also by Chumlea[7, 8] as
Men Y=64.19+2.02×KH-0.04×age R^2 =0.67
Women Y=84.88+1.83×KH-0.24×age R^2=0.65 are popular while estimating body height from knee height.
A negative association between height and age was observed by all authors. Concerning the decline of height, there is one report[3] in which the decline of height with age was seen amongst individuals 45 years and over, and the mean decline of height per year becomes larger according to age. Thus, this study suggests the Knee height to be the best body height proxy indicator developed for estimation of body height according to gender including age as a predictor variable with better accuracy, reproducibility and reliability.

CONCLUSION

The study suggests the Knee height to be the best body height proxy indicator developed for estimation of body height according to gender including age as a predictor variable with better accuracy, reproducibility and reliability.

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