Short Communication

Estimating height and weight in old-age from other anthropometric measurements – a community based cross-sectional study from central Kerala

Jaimy Ann Philip[1], Ivin P Zacharia[1], Sherin Susan Paul[2], Arun N Bhatt[3]

[1]Final Year Medical Student, Malankara Orthodox Syrain Church Medical College, Kolenchery, Kerala, India.
[2]Department of Community Medicine, Pushpagiri Institute of Medical Sciences, Thiruvalla, Kerala, India.
[3]Department of Community Medicine, MOSC Medical College, Kolenchery, Kerala, India.
Correspondence to: Arun N Bhatt, E-mail: communitygeriatrics@gmail.com

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Abstract

Background: Measuring height and weight in old age is often difficult due to imbalance or immobility. Measuring weight and height is important in geriatrics for a number of reasons. Study on estimation of weight and height for bedbound elderly are lacking in India.

Objective: To derive equations for weight and height, for elderly from other convenient measurements.

Materials and Methods: This community based cross sectional study is from a rural setting in central Kerala among 64 ambulant elderly. Weight, height, knee height (KH), calf circumference (CC), and mid arm circumference (MAC) were measured by standard techniques. Sum of circumferences (SC) was calculated by adding MAC and CC.

Result: Summary (mean, SD) of anthropometric measurements are as follows- body mass index (BMI) (23.01, 3.59), weight(55.19, 10.49), height(154.67, 8.43), MAC(27.08, 3.65), CC(31.14, 3.76), SC(58.22, 6.75), and KH(49.13, 3.08). Weight had significant correlation ($p<0.001$) with MAC($r=0.708$), CC($r=0.759$), and SC($r=0.806$). Height had significant correlation ($p<0.001$) with KH($r=0.815$). The formula derived were as follows- Weight=2.037(MAC)+0.069, Weight=2.119(CC)-10.798, Weight=1.254(SC)-17.793, and Height=2.229(KH)+45.135.

Conclusion: It is possible to derive anthropometric equations since there is good correlation between them. The estimates derived in this study were imprecise, but are valuable to plan further studies with larger sample size.

KEY WORDS: Anthropometry, Geriatrics, Palliative care, Old age

Introduction

The old age population in India is on the rise.[1] This mandates more research in old age specific healthcare issues. Measuring height (Ht) and weight (Wt) in old age is important for various reasons. Body mass index (BMI) is an indicator of nutritional status.[2] BMI or change in BMI is associated with mortality in old age.[3] Interpretation of spirometry values involves measurement of height.[4] It is important to estimate Glomerular filtration rate (GFR) to prescribe appropriate dose particularly in old age.[5] GFR estimation involves measurement of weight or body surface area.[6]

In India 8% of the elderly may be bedbound or homebound.[7] Their proportion may rise to 27% after the age of 80 years.[7] Imbalance is another common problem in elderly.[8] Measuring weight and height in old age becomes difficult or impossible due to immobility and imbalance. In this context, this study was planned among ambulant elderly to explore the possibility of estimating height and weight from other convenient measurements. The objectives were to derive simple mathematical formula for estimating height from knee height(KH) and for estimating weight from mid upper arm circumference (MAC), calf circumference (CC), and sum of both these circumferences(SC).

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Table 1. Summary of anthropometric measurements

Measurements	Male (n = 25)		Female (n = 39)		Total (n = 64)	
	Mean	SD	Mean	SD	mean	SD
Height (cm)	162.00	6.79	149.97	5.56	154.67	8.43
Weight (kg)	59.56	11.13	52.38	9.14	55.19	10.49
BMI (kg/m)	22.61	3.54	23.26	3.64	23.01	3.59
Knee height (cm)	51.24	2.40	47.77	2.70	49.13	3.08
Calf circumference (cm)	32.84	3.20	30.05	3.72	31.14	3.76
Mid Upper Arm Circumference (cm)	27.20	3.71	27.00	3.66	27.08	3.65
Sum of circumferences (cm)	60.04	6.24	57.05	6.87	58.22	6.75

Materials and methods

This community based cross sectional study was conducted in a gramapanchayath in central Kerala. Old age was defined as age above 60 years. Persons with deformities of spine and person who could not stand up for measurement were excluded. The sample size of the study was 64. We enrolled 8 participants from 8 randomly selected wards by cluster sampling method. The study was approved by Institutional Ethics Committee. Voluntary written informed consent was obtained from the participants.

Height (Ht), weight (Wt), KH, MAC, and CC were the anthropometric variables in the study. All the measurements were done by standard procedures.[9] Non stretch tape of 0.5cm precision was used to measure height, knee height, calf circumference, and mid arm circumference. Body mass index was classified by classification for Asian adults. The mechanical calibrated weighing machine had a precision of 1kg. Age, gender, and socioeconomic status were the demographic variables. Socioeconomic status was measured by modified Kuppuswamy scale 2014.

Date entry was done in EpiInfo Software Version 7 and analysis was done in R software version 3.1.1. Mean and standard deviations were calculated for anthropometric measurements. A new variable sum of circumferences (SC) was calculated from the data by adding calf circumference and mid upper arm circumference. Carl Pearson correlation coefficients were calculated for height(Ht) with KH and weight(Wt) with CC, MAC and SC. Simple linear regression was done with the same to derive simple equations to estimate height and weight.

Result

There were 64 study participants. Mean age was 70.51 years (SD = 7.58). There were 25(39.06%) males and 39(60.94%) females. Majority, 39(60.94%) belonged to middle socioeconomic class, followed by lower 24(37.50%) and upper 1 (1.56%) socioeconomic classes. According to BMI classification for Asians, 10(15.63%) were underweight, 21(32.81%) were normal, 15(23.48%) were at risk of obesity, 16(25.00%) were in class I obesity and 2(3.13%) were in class II obesity. Mean BMI was 23.01 kg/m (SD=3.59). Mean and standard deviation for anthropometric measurements is given in Table 1.

Summary of correlation and simple linear regression models are presented in Table 2. CC, MAC, and SC had significant correlation with weight(Wt) (p value < 0.001). Carl Pearson correlation coefficients were r = 0.759, r = 0.708, and r = 0.806 for CC and MAC and SC, respectively. KH had significant correlation coefficient,r = 0.815 with height(Ht) (p value < 0.001). The simple linear regression equations for weight(Wt) and height(Ht) with other measurements are as follows- Wt = 2.119(CC) − 10.798, Wt = 2.037(MAC)+ 0.069, Wt = 1.254(SCM) − 17.793, Ht = 2.229(KH) + 45.135. However, these estimates are not precise. The 95% confidence interval for the regression coefficients and Y-intercept of these equations are presented in Table 2.

Discussion

Studies from different settings found knee height useful to predict stature of elderly.[10,11,12] Chumela WC et al found calf circumference and arm circumference useful to predict weight in elderly.[13] Our study shows that weight has significant correlation with mid arm circumference, calf circumference and sum of these circumferences. Similarly, height shows significant correlation with knee height. This indicates a possibility of deriving equations for estimating height and weight which can be useful in bedbound elderly.

Many researchers around the world had given equations to estimate weight and height with combination of anthropometric measurements. Various studies had given equations with combination of measurements like mid arm circumference, abdominal circumference, calf circumference, knee height, skin fold thickness at triceps, arm span, arm length, and many others.[14] Some equations also involved variables age or sex. In our study, multiple linear regression models were not derived due to small sample size.

Anthropometric equations are more accurate than visual assessment which physicians have to resort to for bedbound patients.[15] Research by Bernal-Orozco et al suggest that anthropometry equations derived in one setting do not suit the elderly in another setting.[16] Equations applicable for Indian population need to be developed. The strength of the study

Table 2. Correlation and simple linear models of anthropometric measurements.

Anthropometric measurements		Carl Pearson correlation coefficient (95% CI)	p-value	Regression Coefficient (95% CI)	Y intercept (95% CI)
Dependent variable	Independent variable				
Weight (Wt)	Calf circumference (CC)	0.759 (0.631 – 0.846)	<0.001	2.119 (1.658 – 2.580)	–10.798 (–25.267 – +3.667)
	Mid arm circumference (MAC)	0.708 (0.560 – 0.812)	<0.001	2.037 (1.521 – 2.549)	0.069 (–13.972 – +14.118)
	Sum of circumferences (SC)	0.806 (0.699 – 0.878)	<0.001	1.254 (1.020 – 1.486)	17.793 (–31.467 – –4.119)
Height (Ht)	Knee height (KH)	0.815 (0.711 – 0.883)	<0.001	2.229 (1.827 – 2.320)	45.135 (25.335 – 64.935)

is that it was community based. The major limitations of the study include small sample size and lack of representation of bedbound elderly. Many relevant anthropometric measurements were not explored in the study. However, there is a lack of research on estimation of weight and height for bedbound elderly in India. This study may be a humble first step in this direction.

Conclusion

There are anthropometric measurements which have significant correlation with height and weight. It may be possible to derive useful anthropometric equations. The study gives some basic estimates which can be useful in planning larger study. A study with adequate sample size involving multiple variables and gender specific analysis may give robust estimates. If such anthropometry equations can be derived, that would be beneficial for ageing population in India.

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