

Screening for malnutrition in the elderly population: a tool for estimating height from knee height

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ABSTRACT

Malnutrition in old age is a significant problem. Body Mass Index predicts disease risk both in those termed underweight and in those who are obese. However, BMI may be unreliable in the presence of confounding factors and reliable estimation of height is difficult in the elderly because of vertebral compression, loss of muscle tone and postural changes. Mini Nutritional Assessment is a widely used international questionnaire to evaluate nutritional status of elderly. However, performing MNA is time consuming. The aim of the present study was to develop predictive equations to estimate height from knee height in elderly population. The malnutrition assessed using these equations shows fairly better agreement with malnutrition assessed using MNA questionnaire compared with malnutrition assessed using actually measured height and weight.

Keywords: Malnutrition, MNA Questionnaire, Height, Knee height.

Introduction

Malnutrition is a state in which a deficiency, excess or imbalance of energy, protein and other nutrients causes adverse effects on body form, function and clinical outcome [1]. In the older population, undernutrition rather than overnutrition is the main cause for concern, since its relation to morbidity and mortality is stronger than that of obesity [2]. The prevalence of malnutrition increases with escalating frailty and physical dependence [1].

There is ample evidence of the adverse consequences of malnutrition on physical and psychosocial outcomes [3, 4-6], and seemingly these are independent of underlying disease and disability [7]. Malnourished older people are at increased risk of falls, lengthy hospital stays and rehabilitation, institutionalization, postoperative complications, infections, pressure ulcers, poor wound healing, impaired muscle and respiratory function and death [1, 8, 9].

Body mass index (BMI; weight[kg]/height[m²]) predicts disease risk both in those termed underweight and in those who are obese. The World Health Organization categorizes underweight as BMI < 18.5, normal 18.5 – 24.9, overweight 25 – 29.9, obese 30 – 30.99 and extreme obesity > 40. However, BMI may be unreliable in the presence of confounding factors such as oedema or ascites, and may not identify significant unintentional weight loss if used as a single assessment [6,10,11]. Furthermore, reliable

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measurement of height can be difficult in the elderly because of vertebral compression, loss of muscle tone and postural changes [6,12]. Mini nutrition assessment (MNA) is a widely used international questionnaire to evaluate the nutritional state of seniors with high sensitivity (98.9%), specificity (94.3%) and diagnostic accuracy (97.2%). It closely correlates with biochemical (albumin, prealbumin, transferrin levels, and lymphocyte numbers) and anthropometrical markers (measuring of subcuticular fat, arms circumference) that was verified by a number of clinical studies on wide sets of geriatric patients[13-15]. Performing the MNA is time consuming because MNA itself consists of 4 groups of questions and measurements: basic anthropometrical measurement (BMI, arm, hip circumference, loss of body mass), total condition evaluation (mobility, self sufficiency, chronic defects, presence of acute disease, psychological condition and polypragmasia), eating habits (questions aimed at food and liquid consumption and the ability to eat) and judging the condition of nutrition and health. A certain number of points are allocated to each question; maximum reached is 29 points, minimum 0 point. Normal MNA and a good condition of nutrition is considered above 24 points, endanger risk of malnutrition appears in the range 17-23.5 points and score under 17 verifies malnutrition.

Height and weight are important anthropometric measurements for the assessment of health conditions in people. However, the measurement of height in the elderly who are confined to bed or in wheelchairs or who have spinal deformities can be difficult. Miyazawa reported that there were 76 % of admitted patients who could not have their height and weight measured. In order to avoid these difficulties, alternative methods of estimating height from other anthropometric measurements have been developed. Generally, the knee height method is most common now. At present, the formula devised by Miyazawa and Chumlea [16] are often used in Japan. However, whereas Miyazawa's formula was developed from the data of people aged from 21 years to 97 years from various locations of Japan. Chumlea's formula was developed from the data of people in the US. However, to the extent of our knowledge, not many studies were conducted in India to estimate height from knee height and age. In this paper, we attempted to create a formula to estimate the height using knee height and age in the elderly with the data from a community based cross sectional study conducted at the urban field practice area of PSG Institute of Medical Science and Research, Coimbatore.

Materials and Methods

Study design and population

The urban health centre of PSG Institute of Medical Science and Research has 6 areas on which 3 areas were randomly selected. The selected areas were HUDCO, AD colony, Pattallamman Koil Street. The total numbers of households in these 3 areas were 762. In 565 houses, there were no elderly person and non response was obtained in 43 houses. Hence we surveyed 154 households and interviewed 190 elderly people. All elderly people aged 60 years and above residents at HUDCO Colony, AD colony and Pattallamman Koil Street were included in the study. Subjects having debility or structural defects such as chest or upper limb deformities, those with medical disorders known to have altered body proportions were excluded from the study. Approval for the study was obtained from Institutional Human Ethics Committee (IHEC). Written informed consent was obtained from each patient.

Measurements

The participants were requested to stand straight, with heels together, and height was measured with a measuring tape (Wellknown Syndicate Tirupur, Tamilnadu) measured to the nearest centimeter (cm) and weight was assessed by a digital weighing machine to the nearest kilogram (kg). BMI was calculated as weight in kg by the square of height in meters (kg/m^2). Knee height was measured with the subject seated in a chair, using a measuring tape from top of the knee to the sole level. Measurements were performed on the left leg, positioning the knee and ankle at a 90° angle.

Statistical Analysis

A scatter diagram was initially plotted for knee height and height. We excluded 6 observations having extreme values observed in the correlation from the analysis. Thus the linear regression analysis was performed among 184 observations using SPSS (19.0) for estimating height from knee height and age. An estimation of $y_i = a + b_1x_1 + b_2x_2$ was developed where x_1 is knee height and x_2 is age, a is the intercept, b_1 and b_2 represent the regression coefficients (slopes) of knee height and age. R^2 is the coefficient of determination which is interpreted as the proportion of total variation in height measured through knee height and age. For the actually collected data, using BMI, we defined malnutrition as having $\text{BMI} \leq 18.5 \text{ kg}/\text{m}^2$. This was compared with malnutrition assessed using MNA

questionnaire having score ≤ 17 . The agreement analysis was measured using Kappa statistic. We have further estimated the height using the regression equation developed and BMI was further calculated and malnutrition was then assessed. This was further compared with the malnutrition assessed using MNA questionnaire and agreement analysis was carried out. In Kappa statistic, mild agreement was defined as 0.4 to 0.6, moderate agreement was defined as 0.6 to 0.8 and good agreement was defined as 0.8 to 1.

Results

A total of 184 elderly people were included in the analysis. The mean height and its standard deviation among male adults were 162.31 cm and 7.04 cm and among female adults were 147.32 cm and 6.50 cm. The mean knee height and its standard deviation among male adults were 51.97 cm and 2.46 cm and among female adults were 48.08 cm and 2.72 cm. The mean age and its standard deviation among male adults were

72.79 years and 7.64 years and among female adults were 70.41 years and 8.03 years.

The scatter diagram for actual height and knee height is shown in Figure 1. People who were taller in stature had a higher knee height. Pearson correlation coefficient was 0.837 ($p < 0.01$). The regression equations assessed for estimating height for male and women are given in Table 1.

The agreement between malnutrition estimated from BMI using the regression equations and malnutrition estimated using MNA score shows fairly moderate agreement (Kappa = 62%) compared with the mild agreement between malnutrition estimated from BMI using the height and weight measured and malnutrition estimated using MNA score (Kappa=56%) (Tables 2 &3)

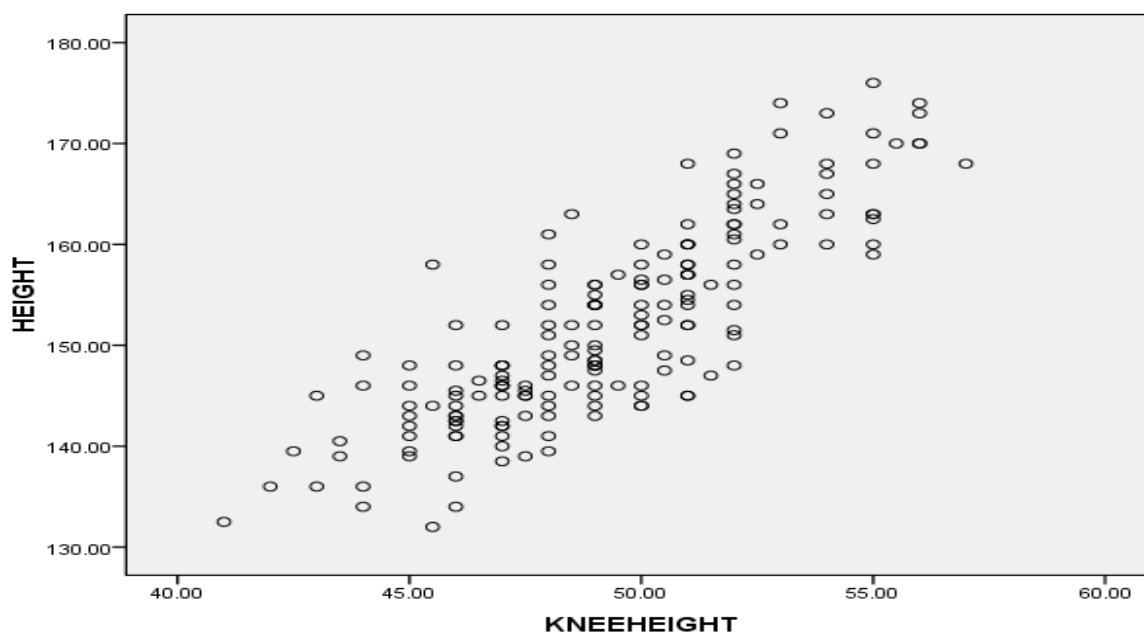


Fig 1: Scatter diagram for height and knee height (n=184)

Table 1: Estimating height from knee height and age based on gender

Regression equation	R ² (%)
For men, Height =2.274*Knee height-0.063*age+48.732	62.7
For women, Height =1.728*Knee height-0.145*age+74.503	58

Table 2: Agreement between malnutrition assessed using actual BMI compared with malnutrition assessed using MNA questionnaire

Actual BMI (Kg/m ²)	Malnutrition		Kappa
	Yes	No	
< 18.5	19	5	0.555
≥ 18.5	18	148	

Table 3: Agreement between malnutrition assessed using estimated BMI compared with malnutrition assessed using MNA questionnaire

Estimated BMI (Kg/m ²)	Malnutrition		Kappa
	Yes	No	
< 18.5	23	7	0.620
≥ 18.5	14	146	

Discussion

In this study we found that the knee height is highly correlated to stature. There are many equations for estimating stature from knee height, which have been reported by Chumlea[16], Lera[17], Chumlea [18], Han [19], Chumlea[20], Palloni [21], Donini [22], Zhang [23], Myers [24], Shahar [25], Cockram [26], Knous [27] in various countries. In Japan, the equations by Miyazawa and also by Chumlea are popular when estimating a person's height from knee height. However in India to the extent of our knowledge, this is the first study to estimate height from knee height.

To evaluate the relationship between height and knee height or other factors, all authors who mentioned above used the simple or multiple linear regression models. In both models, the slopes for knee height were approximately 1.8 and as the slopes for age ranged from 0.07 -0.26. In our study also, we observed the similar results. The R² values for men and women are 62.7% and 58% respectively which shows similar goodness of fit as observed in other parts of the world. There is a report that arm length may be used as a substitute for measurement of height. We also examined the correlation between arm length and height but could not find much correlation in the analysis.

Conclusion

The measurement of knee height provides a simple, quick and accurate means of estimating height for elderly whose height cannot be measured. The findings clearly support the observations from other parts of the world. Large scale community based studies can throw more light in this field.

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