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ORIGINAL PAPER

External validation test of body height estimation on outpatient radiotherapy clinic of Dr. Cipto Mangunkusumo General Hospital

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Abstract

Background : Stature is required to calculate body mass index and determine the energy needs of patients in nutritional medical therapy. Difficulty was found to obtain stature data in patients who are unable to stand. Therefore, there are some height estimation formula to predict the actual height using knee height. This study aimed to validate the Chumlea formula on outpatient clinic of Dr. Cipto Mangunkusumo General Hospital, Indonesia.

Methods : This cross-sectional study used 90 respondents selected by consecutive sampling. Actual height, knee height, age and gender data were collected. Estimated height using the three of Chumlea formula. Pearson correlation was used to see the correlation between actual height and estimated height. Paired t-test were used to determine the difference significance.

Results : The average age of the subjects was 45±10 years old with actual height 157±10 cm, and knee height 48.8±3.5 cm. A strong positive correlation was found between actual height with all estimated height on male ($p=0.000$; $r > 0.8$) and female subjects ($p=0.000$; $r > 0.6$). However, comparison between actual height and estimated height showed no significant differences only in Chumlea L1 formula ($p=0.087$) and Chumlea L3 formula ($p=0.824$) on the male subjects.

Conclusions : Chumlea L1 and Chumlea L3 formula was a valid fomulation for calculating the estimated body height in adult male patients. There was no valid Chumlea's formulation to estimate body height in female patients.

Keywords: Body height, Stature estimation, Knee height, Chumlea formula

Introduction

Measurement of stature is a part of the anthropometric examination. Measurement and recording of body height is one component of calculating the body mass index (BMI), which is useful for assessing the risk of malnutrition in hospitalized patients.[1] Tonder, et al.[2] revealed that the prevalence of malnutrition in hospitals was up to 78%, and almost a quarter was already malnourished at the time of admission.[2,3] Knowing the high number of malnutrition, anthropometric data at the time of admission is necessary. Nonetheless, not all patients admitted to the hospital have complete anthropometric data.

Assessing nutritional status is important for nutritional medical therapy interventions, especially in patients treated in hospitals.[4] Therefore, stature data is needed to calculate the patient's energy needs, which are included in nutritional medical therapy.[5]

Difficulty was found to obtain body height data in patients who are unable to stand.[6] Measurement tape can be used for measuring body height

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estimation, by obtaining the body length, but its validity is still doubtful. In addition, anthropometric measurement using tools also require calibration process periodically.[7] Some of these reasons certainly affect hospital costs.

There are some estimated height calculations have accomplished in previous studies. This study aims to validate three of the equations developed by Chumlea to estimate stature of the patients.

Methods

Research Design

This research was an analytical study with cross sectional design.

Recruitment

This study used 90 subjects selected by consecutive sampling. The population that fulfilled the research criteria were accepted as the respondents of the study until the required number of samples was reached in accordance with the calculation of the number of samples. Respondents that fulfill the research criterias were given an information sheet, explained the aim of the study and the examination to be accomplished.

Furthermore, subjects who were responsible to participate in the study were asked to fill out and sign the consent form to participate in the study. General and demographic data collection was completed by interview to regarding the characteristics of the subjects. Then, the subjects were measured for actual height and knee height.

Subjects were all patients who were able to stand and did not have any postural deformities in outpatient unit Radiotherapy Clinic Dr. Cipto Mangunkusumo General Hospital, Jakarta, Indonesia. Data collected in the period August-November 2019. The sample were part of the accessible population who are willing to participate in the research and fulfill the research criterias. The number of ethical approval is KET-368/UN2.F1/ETIK/PPM.00.02/2019.

Data collection

Height (cm) was measured to the nearest centimeter using a microtoise, along a surface as flat as possible such as a door or a wall. Measurement of height was carried out twice and the results were the average of the two measurements. Knee height (cm) was measured once per person with a knee height caliper (SECA® 207) to the nearest centimeter on the right side with an angle of 90° between the thigh and the leg according to Chumlea,et al[8]. The caliper was placed in line with the lateral malleolus and the head of the fibula, with the soft tissue compressed, the distance from the sole of the foot to the top of the thigh immediately above the condyles of the femur was measured.

Table 1 Chumlea formulation for estimate the stature[8,9]

Formulation	Equation
Male Stature	
First Chumlea's formulas for Caucasian people (L1)	H (cm) = 64.14 + (2.02 × KH [cm]) − (0.04 × age [y])
Chumlea’s formulas for white people (L2)	H (cm) = 71.85 + (1.88 × KH [cm])
Chumlea’s formulas for black people (L3)	H (cm) = 73.42 + (1.79 × KH [cm])
Female Stature	
First Chumlea's formulas for Caucasian people (P1)	H (cm) = 84.88 + (1.83 × KH [cm]) − (0.24 × age [y])
Chumlea’s formulas for white people (P2)	H (cm) = 70.25 + (1.87 × KH [cm]) − (0.06 × age [y]
Chumlea’s formulas for white people (P3)	H (cm) = 68.1 + (1.86 × KH [cm]) − (0.06 × age [y])

Formula analysis

Estimated height (H) is obtained from calculations using the Chumlea formula[8,9] according to sex, age (y) and knee height (KH) measurement. The formulation can be seen in the **Table 1**.

Data Analysis

The data were collected from the research subjects were recorded on each research form, edited, and coded. The data was entered into a computer and processed using the Statistical Package for Social Sciences (SPSS) program. Statistical analysis was performed using the paired t-test and Pearson Correlation test.

Results

Data were collected on 90 patients in the radiotherapy clinic of Dr. Cipto Mangunkusumo General Hospital. The distribution of subjects can be seen in **Table 2**. The patients involved in this study were in the range age of 45 ± 10 years old, with 44 men (49%) and 46 women (51%). The height of all patients in the range of 157 ± 10 cm, with the height of men 165 ± 6.7 cm and women 150 ± 6 cm. The knee height of all patients was found to be 48.8 ± 3.5 cm with the knee height of men 51.4 ± 2.6 cm and female 46.3 ± 2.3 cm. Table 3 shows the correlation between actual height and estimated height using the Chumlea formula,

Table 2 Distribution of patients' age, actual height, and knee height (n=90)

Variables	Result
Age (year)	45±10*
Gender	
Male, n (%)	44 (49)
Female, n (%)	46 (51)
Actual Height (cm)	
Male	165±6.7*
Female	150±6*
Knee Height (cm)	
Male	51.4±2.6*
Female	46.3±2.3*

*mean ± standar deviation

Table 3 Correlation between actual stature and estimated stature using formula r = Pearson Correlation; *Statistically Significant (p<0.05)

Variable	r	p
Male Stature		
Chumlea L1	0.834	0.000*
Chumlea L2	0.833	0.000*
Chumlea L3	0.833	0.000*
Female Stature		
Chumlea P1	0.662	0.000*
Chumlea P2	0.755	0.000*
Chumlea P3	0.755	0.000*

Pearson correlation showed a strong correlation in both the male and female groups with p 0.000 in all formulas.

Table 3 shows that among all Chumlea formula, only Chumlea L1 and Chumlea L3 formulas for male patients did not have a significant difference with the actual height measurement, with p-value of 0.087 for Chumlea L1 and p-value of 0.824 for Chumlea L3. Meanwhile, in female patients, all of the Chumlea formulas showed a significant difference between the actual height and the estimated height.

Discussion

Determination of nutritional status for patients in hospital is very important for malnutrition screening and therapy. Nutritional status is also an important clinical outcome to be monitored during the patient's stay in the hospital. One component of determining nutritional status is height. To measure body mass index (BMI), for example, height data is needed. In hospital, height measurement is often difficult, especially in patients who are unable to stand or have deformities or postural abnormalities. There are several alternatives to determine the estimated height using the formulas generated from previous studies using components of body parts measurements such as knee length, ulna length, arm-span, demi-span and so on.

Table 4 Comparation between actual stature and estimated stature using formula

Formula	Mean± SD/ Median (Minimum-Maximum)	p
Male		
Actual Stature	165±6.7	
Chumlea L1	166±5.3	0.087t
Chumlea L2	168.5±4.9	0.000 t*
Chumlea L3	165.5±4.64	0.824 t
Female		
Actual Stature	150±6	
Chumlea P1	158±4.7	0.000 t*
Chumlea P2	154±4.3	0.000 t*
Chumlea P3	151±4.2	0.000 t*

t Paired T Test
*Statistically Significant ($p<0.05$)

This study compared the actual height measurements using microtoise and estimated height measurements using several formulas developed by Chumlea that use knee length as the component of the formula.[8,10] Knee length is often used because it does not decrease due to age.[11]

This study measured the actual height and the estimated height using all the Chumlea formulas showed that male adult subjects are taller than women. This is aligned with previous studies in various countries and races which found that men's height is higher than women's. Moelyo et al.[12] showed that in 1995 the male's height was taller (165.8 cm) than female (153.6 cm) and consistent for the last 40 years (1955-1995) both in rural, small cities, and large cities, with positive secular trends from 1955-1995 for males 95% CI 1.3 (1.1-1.4) cm and for females 95% CI 0.9 (0.8-1.0) cm. Genetic factors played role in sexual dysmorphism, which make males 8% taller than females over the last 110 years.[12] Adult male subjects in this study have an average height of 165±6.7 cm and knee height of 51.4±2.6 cm, which is higher than the height and knee height of adult female patients, namely 150±6 cm and 46.3±2.3 cm. These results are in accordance with the study of Murbawani et al.[13] in elderly subjects, where men have higher knee heights than women.[13]

Chumlea Formula Validity

In this study, there was a strong correlation between the estimated height using the Chumlea formula and actual height. However, after analyzing the difference between the two measurements, the results were not significantly different only for the estimated height using Chumlea L1 and Chumlea L3 formulas. These two formulas have a difference of <1 cm from the actual stature, which is 0.97 cm in the Chumlea L1 formula and 0.13 cm in the Chumlea L3 formula. Meanwhile, in female subjects, although all formulas were strongly correlated with actual stature, there was a significant difference between actual height and estimated height using all formulas. So according to the results of this study, none of the Chumlea formulas can be used to estimate the height of adult female patients. This may be because the Chumlea formula was developed especially in the Caucasian race which has very different characteristics from the Indonesian race, especially women. The predictive equation that has been used so far using the Chumlea formula also does not include subjects with overweight and obesity[4], therefore in this study it does not exclude subjects with overweight or obesity.

Conclusions

From this study, we conclude that estimated height by Chumlea L1 formulation (cm) = 64.14 + (2.02 × knee height [cm]) − (0.04 × age [y]) and estimated height by Chumlea L3 formulation (cm) = 73.42 + (1.79 × knee height [cm]) were valid fomulation for calculating the estimated body height in adult male patients in Dr. Cipto Mangunkusumo General Hospital. Meanwhile, there was no valid Chumlea's formulation for calculating the estimated body height in adult female patients.

Potentials for future research

Further studies are needed with larger number of participants to obtain a new calculation formula that can be used specifically for patients treated at the Dr. Cipto Mangunkusumo General Hospital. We suggest to provide a knee height measuring device to apply this estimated stature measurement for bed rest patients at the Dr. Cipto Mangunkusumo General Hospital.

Future studies are expected to test the validity of using other formulas with other measurement components such as fathom length, or half fathom length and the like to determine the estimated height of adult female.

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Conflict of Interest

Authors declared no conflict of interest regarding this article.

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References

1. Charani E, Gharbi M, Hickson M, Othman S, Alfituri A, Frost G, dkk. Lack of weight recording in patients being administered narrow therapeutic index antibiotics: A prospective cross-sectional study. BMJ Open 2015;5:1–6.
2. Tonder EV, Gardner L, Cressey S, Edward RT, Gerber K. Adult malnutrition: Prevalence and use of nutrition-related quality indicators in South African publicsector hospitals. SAJCN 2017;4:1–7.
3. Kubrak C, Jensen L. Malnutrition in acute care patients: A narrative review. Int J Nurs Stud2007;44:1036–54.
4. MeloA PF, Salles RK, Vieira FGK, Ferreira MG. Methods for estimating body weight and height in hospitalized adults: A comparative analysis. RBCDH 2014:475–484.
5. Rabito EI, Vannucchi GB, Suen VMM, Neto LLC, Marchini JS. Weight and height prediction of immobilized patients. Rev Nutr 2006;19:655–61.
6. Jung MY, Chan MS, Chow VSF, Chan YTT, Leung PF, Leung EMF, dkk. Estimating geriatric patient's body weight using the knee height caliper and mid-arm circumference in Hong Kong Chinese. Asia Pac J Clin Nutr 2004;13:261–4.
7. Olguin CQ, Zuniga AES, Morales VS, Cruz MG. Validation of a new formula for predicting body weight in a Mexican population with overweight and obesity. Nutr Hosp 2013;28:690-3.
8. Chumlea WMC, Guo SS, Wholihan KMS, Cockram D, Kuczmarski RJ, Johnson CL. Stature prediction equa tions forelderly non-hispanic white, non-hispanic black, and mexican-american person developed from NHANES III data. J Am Diet Assoc 1998;98:137–42.
9. Chumlea WMC, Roche AF, Steinbaugh ML. Estimating stature from knee height for persons 60 to 90 years of age. J Am Geriatr Soc 1985; 33: 116-20
10. Chumlea WMC, Guo SS, Steinbaugh ML. Prediction of stature from knee height for black and white adults and children with application to mobility impaired or handicapped persons. J Am Diet Assoc 1994;94:1385–8.
11. Pieterse S. Anthropometric measurement method. Help age symposium report. 1997;13-8.
12. Moelyo AG, Sitaresmi MN, Julia M. Secular trends in Javanese adult height: the roles of environment and educational attainment. BMC Public Health. 2022;22(712):1-9.
13. Murbawani EA, Puruhita N, Yudomurti. Tinggi badan yang diukur dan berdasarkan tinggi lutut menggunakan rumus Chumlea pada lansia. M Med Indones 2012;46:1-6.