Nutrition 42 (2017) 46–50

Contents lists available at ScienceDirect

Nutrition

journal homepage: www.nutritionjrnl.com

Applied nutritional investigation

Validity of equations using knee height to predict overall height among older people in Benin

Pierre Jésus M.D., Ph.D. [a,b,c,*], Carmelle Mizéhoun-Adissoda PharmD., Ph.D. [d,e], Dismand Houinato M.D., Ph.D. [b,c,e], Pierre-Marie Preux M.D., Ph.D. [b,c], Philippe Fayemendy M.D., M,Sc. [a,b,c], Jean-Claude Desport M.D., Ph.D. [a,b,c]

[a] Nutrition Unit, Centre for Severe Obesity and Expert Centre for Home Parenteral Nutrition, University Hospital of Limoges, Limoges, France
[b] INSERM UMR1094, Tropical Neuroepidemiology, School of Medicine, Limoges, France
[c] Institute of Neurologic Epidemiology and Tropical Neurology, University of Limoges, Limoges, France
[d] School of Nutrition and Dietetic, Faculty of Health Science, University of Abomey-Calavi, Cotonou, Benin
[e] Laboratory of Non-communicable and Neurologic Diseases Epidemiology (LEMACEN), Faculty of Health Science, University of Abomey-Calavi, Cotonou, Benin

ARTICLE INFO

Article history:
Received 7 February 2017
Accepted 31 May 2017

Keywords:
Height
Chumlea's formulas
Elderly
Benin

ABSTRACT

Objectives: Chumlea's formulas are a validated means of predicting overall height from knee height (KH) among people >60 y of age, but, to our knowledge, no formula is validated for use in African countries, including Benin. The aim of this study was to compare height provided by predictive formulas using KH to measured height in an elderly population in Benin.
Methods: Individuals >60 y of age in Benin underwent nutritional assessment with determination of weight, body mass index (BMI), height, and KH. A Bland-Altman analysis was carried out by sex and age. The percentage of predictions accurate to ±5 cm compared with the measured height was calculated. The tested formulas were Chumlea's formulas for non-Hispanic Black people (CBP) and two formulas for use among Caucasians.
Results: Data from 396 individuals (81.1% male) were analyzed. The three formulas achieved 98% accuracy, but with 4.6% risk for error (±2 SD: −6 to +9 cm), which appeared to make them unfit for the whole population. Nevertheless, if a level of prediction ±5 cm is considered acceptable in clinical practice, the CBP formula achieved 83.1% accuracy. Moreover, there was no significant difference in BMI calculated with the measured and the predicted height, and the nutritional status based on BMI did not differ.
Conclusion: CBP formulas seem applicable in 83% of cases (±5 cm) to assess the height with KH of older people in Benin and do not overestimate the prevalence of malnutrition.

Introduction

Height measurement is an essential part of nutritional assessment. In children, it is used to assess growth, and in both children and adults, it is used with weight to calculate body mass index (BMI). BMI is a measure of nutritional status that allows for attribution of a state of malnutrition, normal weight, overweight, or obesity [1]. BMI may be the only criterion available with which to evaluate the nutritional status of a patient, but without height, it cannot be calculated. However, height measured in suitable conditions, with a measuring rod in the upright position along a flat surface, may not be possible. Indeed, it may not be possible to measure height directly at all if the patient cannot maintain the upright position or has a deformation of the spine. Chumlea et al. have published formulas predictive of height for people age >60 y according to age, sex, and knee height (KH) [2,3]. These formulas have been validated in various populations, including Caucasians, Black Americans, and Hispanics [2,3]. Other teams have validated formulas for countries in Latin America and in Taiwan [4,5]. However, to our knowledge, there is no validated formula for African countries including Benin. In their work carried out in the Republic of Congo and the Central African Republic, Pilleron et al. used Chumlea's formulas for Black

* Corresponding author. Tel.: + 33 55 505 6621; fax: + 33 55 5 5 6354.
E-mail address: pierre.jesus@chu-limoges.fr (P. Jésus).

http://dx.doi.org/10.1016/j.nut.2017.05.015

Americans, although they are not validated for this population [6, 7]. Marais et al. used Chumlea's formulas in a study in South Africa, but did not specify the study population [8]. Multiple studies have focused on the nutritional status of the elderly in Africa with reference to various diseases [6,7,9–19]. It is essential to have a reliable tool for the evaluation of height to minimize errors or missing data for the BMI. The purpose of this study was to compare the assessment of height with different Chumlea's formulas to the measured height in elderly people living in the country of Benin.

Methods

Population

This was a cross-sectional study performed in the city of Cotonou, the capital of Benin (urban area). The inclusion criteria were black people nationals of Benin, living in Cotonou, aged >60 y without amputation or spine curvation, and affiliated with the Caisse Nationale de Sécurité Sociale (CNSS) of Benin. About 2000 retired individuals aged ≥50 y depended on the CNSS in 2016 and received medical assessment. The choice of the CNSS as a framework for this study allowed us to identify most people >60 y old in Cotonou. Retired people >60 y of age living at home were consecutively assessed from June 20–24, 2016 in the framework of their monitoring in CNSS.

Ethics

The study protocol received the approval of the Ethics Committee of Biomedical Sciences at the University of Abomey-Calavi, and the authorization of the Director of the CNSS. All participants and/or their families gave their informed consent before being included in the study.

Anthropometric measurements

Anthropometric measurements were performed by a trained investigator (CMA) and once per person. Weight (kg) was measured in underwear in an upright position to the nearest 100 g on a portable mechanical balance initially calibrated (753 E model, Seca, Hamburg, Germany). Height (cm) was measured to the nearest centimeter using a carpenter meter (Seca), along a surface as flat as possible such as a door or a wall. KH (cm) was measured once per person with a pediatric height caliper to the nearest centimeter on the right side with an angle of 90° between the thigh and the leg according to Chumlea et al. [2]. 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. BMI was calculated with the following formula: BMI (kg/m^2) = weight (kg)/height^2 (m^2). Malnutrition was defined as a BMI <18.5, normal status between 18.5 and 24.9, overweight between 25 and 29.9, and obesity ≥30 kg/m^2, according to World Health Organization recommendations [1].

Formulas analyzed

Three height predictive formulas were analyzed, using sex, age, and KH.

1. Chumlea's formulas for non-Hispanic Black people (CBP) are as follows: men: height (cm) = 79.69 + (1.85 × KH [cm]) − (0.14 × age [y]); women: height (cm) = 89.58 + (1.61 × KH [cm]) − (0.17 × age [y]) [2].
2. First Chumlea's formulas for Caucasian people (CC1): men: height (cm) = 64.14 + (2.02 × KH [cm]) − (0.04 × age [y]); women: height (cm) = 84.88 + (1.83 × KH [cm]) − (0.24 × age [y]) [3].
3. Second Chumlea's formulas for Caucasian people (CC2): men: height (cm) = (2.08 × KH [cm]) + 59.01; women: height (cm) = 75 + (1.91 × KH [cm]) − (0.17 × age [y]) [8].

Data management and analysis

The results are given for quantitative criteria as mean ± SD and for qualitative data as percentages (%). The normality of the distribution of our population was tested with the Shapiro-Wilk test. The tests used for comparison of quantitative data were the nonparametric tests of Mann–Whitney and of Kruskal–Wallis if more than two groups, and the χ^2 test for the comparison of qualitative data. Predicted height was compared with height as measured using Bland–Altman analysis [20]. The percentages of prediction between the 95% limit of agreement (±2 SD) and the error risk were computed. The mean percentage difference between predicted height and measured height (bias) was calculated. As the thresholds of ±2 SD did not seem appropriate for use in clinical practice, we adopted thresholds of ±5 cm between predicted and measured height, and recalculated the percentage of accurate prediction accordingly. This new threshold of ±5 cm (3% of the measured height) seemed clinically more acceptable but without reference to justify it. A predicted height of more than 5 cm lower than measured height was considered underprediction and more than 5 cm higher as overprediction. When predicted height was between ±5 cm of measured height, it was considered accurate enough for daily practice. $P < 0.05$ was the limit of significance. Data were analyzed using GraphPad Prism 6.0 (GraphPad Software Inc, La Jolla, CA, USA).

Results

This study involved 396 individuals with a mean age of 66.6 ± 5.2 y and height of 165.4 ± 8 cm. Men (n = 321, 81.1%) were nonsignificantly older than women (n = 75, 18.9%; 66.4 ± 4.9 y versus 67.7 ± 6.1 y). However, men were taller than women (167.7 ± 6.5 versus 155.5 ± 5.7 cm; $P < 0.0001$), and their BMI was lower (23.9 ± 4.2 versus 28 ± 5.8 kg/m^2; $P < 0.0001$).

The results of predicted height with the three Chumlea's formulas are presented in Table 1. In the total population, the percentage of prediction between the 95% limits of agreement (±2 SD) was 98% (−6.2 to 8.9 cm) for CBP formula, 98% (−6.0 to 9.4 cm) for CC1, and 98.2% (−5.6 to 9.5 cm) for CC2. There was no significant difference among the three formulas. The error risks were 4.6%, 4.6%, and 4.5% for CBP, CC1, and CC2, respectively. Figure 1 shows the Bland–Altman plots for the three formulas, for the total population, and for men and women.

With a threshold of ±5 cm, the percentage of accurate prediction then decreased to 83.1% for the CBP formula, 80.3% for CC1, and 78.5% for CC2. There was no significant difference among the three formulas. However, prediction formulas overestimated the height in 12.4%, 15.9%, and 18.2% of cases with CBP, CC1, and CC2, respectively. CC2 overestimated height more often than CPB ($P = 0.023$).

The percentage of accurate prediction (±5 cm) according to the formula, sex, and age is shown in Figure 2. The different formulas were less well adapted for women >70 y, but the number of heights analyzed was small (n = 26).

The average BMI (24.7 ± 4.9 kg/m^2) calculated with the measured height was not significantly different from those calculated with predictive formulas (Table 2). Additionally, the nutritional status based on BMI was no different with measured height and height predicted by CBP and CC1. Only the percentage of malnourished people using CC2 was higher than using the measured height (11.9 versus 7.3%; $P = 0.03$; Table 2).

Discussion

To our knowledge, this is the first study validating predictive formulas for height using the KH measurement in people >60 y of age in sub-Saharan Africa. Multiple studies have focused on the nutritional status of the elderly in Africa in different diseases [6,7,9–19]. In Benin, the studies were mainly focused on the nutritional status of children [21–24]. In adults, one study focused on the nutritional status of people with epilepsy in Benin [25]. Only one study on the prevalence of dementia was focused on the nutritional status of people >65 y of age in this country (N = 1139) [26]. In this age group and country, the distribution of the nutritional status is 8.8% malnourished, 48.4% normal status, 25.3% overweight, and 17.5% obese [26]. These data are close to ours (7.3%, 50.5%, 29.3% and 12.9%, respectively). In the study by Paraïso et al. [26], the criterion used to assess nutritional status was BMI, requiring height for its calculation [1]. It is therefore