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Original

Assessing nutritional status in the elderly; evaluation of Chumlea's equations for weight

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Abstract

Background: **Weight is one of the most important parameters in assessing nutritional status. However, weight can be difficult to measure in elderly people who are unable to stand. Chumlea et al. created two equations to estimate weight in non-ambulatory patients using readily available body measurements.**

Objective: **The aim of the study is to analyze the usefulness of Chumlea's equations in assessing nutritional status of elderly hospitalized patients.**

Methods: **We measured weight, height, arm and calf circumference, subscapular skinfold and knee height of 82 hospitalized elderly patients, all of whom were able to stand. Estimated weight (EW) was obtained by Chumlea's equations. Body mass index (BMI) and Mini Nutritional Assessment test (MNA) were calculated using actual weight and EW. Bland-Altmann analysis and intraclass correlation coefficient (ICC) between real and estimated parameters were assessed.**

Results: **We found a statistically significant ICC between actual weight and EW (r = 0.926), real BMI and estimated BMI (r = 0.910) and real MNA and estimated MNA (r = 0.982) (P < 0.001). Chumlea's equations, however, underestimated weight: 54.05 (DS 11.88) *vs* 61.46 (DS 13.08); BMI: 22.30 (DS 4.61) *vs* 25.36 (DS 5.17) and MNA: 22.73 (DS 4.43) *vs* 23.30 (DS 4.33) (P<0.001). In spite of this underestimation, estimated MNA detected 100% of patients malnourished and 96% of those at risk of malnutrition.**

Conclusions: **Results obtained by Chumlea's equations showed a good ICC with actual body weight and real BMI and MNA, but values were underestimated. These equations can be useful to detect undernourished hospitalized elderly patients.**

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Key words: *Elderly. Nutritional status. Weight. Body mass index.*

VALORACIÓN DEL ESTADO NUTRICIONAL EN EL ANCIANO; EVALUACIÓN DE LAS ECUACIONES DE CHUMLEA PARA EL CÁLCULO DEL PESO

Resumen

Introducción y objetivo: **El peso es uno de los parámetros más importantes en la valoración del estado nutricional. Sin embargo puede ser difícil de medir en ancianos que no sean capaces de manetner la bipedestación. Chumlea et al. crearon dos ecuaciones para estimar el peso en pacientes no deambulantes usando medidas corporales sencillas de obtener. El objetivo del estudio es analizar la utilidad de las ecuaciones de Chumlea en la valoración del estado nutricional de los pacientes ancianos hospitalizados.**

Métodos: **En 82 pacientes ancianos hospitalizados, capaces de mantener la bipedestación, se midieron los siguientes parámetros: peso, altura, circunferencia braquial y de la pantorrilla, pliegue subescapular y altura talón-rodilla. Se calculó el peso estimado (EW) con las ecuaciones de Chumlea y con el peso real y el peso estimado se calculó el índice de masa corporal (BMI) y el Mini Nutritional Assessment test (MNA). Se compararon los parámetros reales I los estimados con la correlación de Pearson.**

Resultados: **Se encontraron correlaciones estadísticamente significativas entre el peso real y el estimado (r = 0,93), entre el BMI y el BMI estimado (r = 0,916) y entre el MNA y el MNA estimado(r = 0.982) (P < 0,001). Sin embargo las ecuaciones de Chumlea infraestiman los valores reales: 54,05 (DS 11,88) *vs* 61,46 (DS 13,08); BMI: 22,30 (DS 4,61) *vs* 25,36 (DS 5,17) y MNA: 22,73 (DS 4,43) *vs* 23,30 (DS 4,33) (P < 0,001). A pesar de ello el MNA estimado detecta el 100% de los pacientes malnutridos y el 96% de los que tienen riesgo de malnutrición.**

Conclusiones: **Los resultados obtenidos con las ecuaciones de Chumlea muestran una Buena correlación entre el peso, el BMI y el MNA reales y los estimados aunque los valores están infraestimados. Estas ecuaciones pueden ser útiles para detectar pacientes ancianos hospitalizados malnutridos.**

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Palabras clave: *Anciano. Estado nutricional. Peso. Índice de masa corporal.*

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Introduction

Malnutrition is a major geriatric syndrome associated with poor health status and high mortality.[1,2,3] It is therefore essential to assess nutritional status in this population in order to identify patients with malnutrition, to determine the causes of this condition, and to try to correct these.

Anthropometric parameters play a key role in nutritional assessment.[4]

Weight is the anthropometric measure that best relates to malnutrition, especially if there are changes from baseline weight.[5,6] Furthermore, weight must be known in order to use tools such as body mass index (BMI) and the Mini Nutritional Assessment test (MNA) for nutritional screening. In hospitalized or institutionalized elderly, however, it is not always possible to determine weight on a conventional scale because many patients have difficulty standing. Alternative methods to measure weight are chair scales and hoist scales, but such equipment is not available in all health care centers.

In 1988, Chumlea et al. created two equations to calculate weight in elderly patients from four readily available body measurements: arm circumference, calf circumference, subscapular skinfold, and knee height. They used a sample of nursing home patients with limited mobility to cross-validate the equations. Two independent observers recorded the measurements. Results showed little variation; differences in actual and predicted weight ranged from 0.1 to 1.8 kg. A separate independent sample was used to test a clinical validation in non-ambulatory nursing-home residents. The authors stated that their results were more varied, but that in this sample data collection was carried out by nursing home staff members rather than trained research personnel.[7] Although it is preferable to obtain real weight measurements whenever possible, Chumlea's equations could be a simple tool to assess nutritional status in patients with limited mobility.

Objective

The aim of this study was to determine the usefulness of Chumlea's equations in assessing the nutritional status of elderly hospitalized patients by comparing the parameters estimated using this formula with actual weight and real BMI and MNA.

Methods

Setting

The study was conducted in the geriatric ward at Hospital de la Santa Creu i Sant Pau, a tertiary university hospital of 700 beds in an urban area.

Subjects

Over a four-month period, from January 2009 to April 2009, all inpatients over 65 years who agreed to participate in the study were included. Inclusion criteria were: age over 65 years, ability to stand, and ability to answer questions. We excluded patients with moderate or severe cognitive impairment and those with edema or ascites from any cause.

Data collection

Data were recorded on the first day of admission or within 72 hours if at weekends. Age, sex, comorbidity measured by Charlson index,[8] basic activities of daily living measured by Barthel index,[9] place of residence, number of drugs and diagnosis at admission were recorded for each patient. Each patient's weight and height were obtained using a stadiometer scale. We measured arm and calf circumference using a flexible metal tape, subscapular skinfold with a skinfold calliper, and knee height with a portable anthropometer. Measurements were performed by an internal medicine physician with experience in obtaining these measurements. Each measurement was repeated three times and the mean was calculated in case of differences.

Measurements

BMI is based on the relationship between weight and height and is a standard method for assessing nutritional status. We calculated BMI for each patient and divided this into 5 categories according to World Health Organization recommendations: underweight (< 18.5), normal (18.5 to 24.99), overweight (25-29.99), obese (30-39.99), morbid obese (> 39.99).[10]

The MNA is a screening test that includes 18 questions relating to: anthropometry (BMI, weight loss, mid-upper arm and calf circumference), general state (drugs, mobility, pressure ulcers, lifestyle, psychological stress, and neuropsychological problems), a dietary questionnaire (number of meals, food and fluid intake, autonomy of feeding) and subjective assessment (self-perception of health and nutrition). The MNA score is the sum of the points for the 18 items. A total score > 24 represents no malnutrition, 17-23.5 represents risk of malnutrition, and < 17 is considered malnutrition.[11] This test was administered to all patients included in the study and final scores were recorded. A Spanish version of this test is used routinely in our center to assess nutritional status.

To obtain estimated weight (EW) using Chumlea's equations[7] we needed the following body measurements: arm circumference (AC), calf circumference (CC), subscapular skinfold (ST), and knee height (KH).

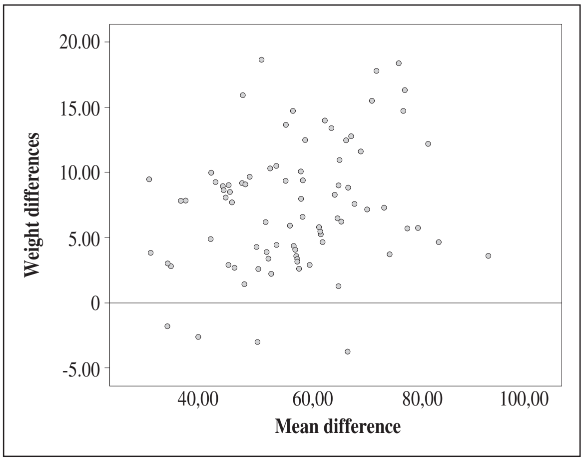

Fig. 1.—Shows differences between actual weight and estimated weight using Bland-Altmann analysis. In most cases weight is underestimated.

The Chumlea equation for women is: Weight = (AC x 0 98) + (CC x 1. 27) + (ST x 0. 4) + (KH x 0. 87) - 62.35, and the Chumlea equation for men is: Weight = (AC x 1.73) + (CC x 0.98) + (ST x 0.37) + (KH x 1.16) - 81.69.

Using these data we calculated EW, estimated BMI (EBMI), and estimated MNA (EMNA).

Statistical analysis

Descriptive analysis for continuous variables is expressed as mean ± standard deviation (SD), unless indicated otherwise. For categorical variables we used Fisher's exact test. Variables are expressed in percentages. Correlations between actual weight and EW, between real BMI and EBMI, and between MNA and EMNA were made using Bland-Altmann analysis and intraclass correlation coefficient (ICC). We used the SPSS Statistical Package (version 18) for all analysis (SPSS Inc., Chicago, IL, USA).

Results

We included 82 patients, 61% women, with a mean age of 83.63 (SD 6.62) years. Mean Charlson index was 1.99 (SD 1.36) and mean Barthel index was 86.12 (SD17.11). Most patients (87.8%) lived at home (34.7% of them alone) and 12.2% lived in nursing homes. Early dementia was observed in 14.6%. The sample took a mean of 6.84 (SD 4.63) drugs per day.

All patients were admitted for medical reasons, mainly lower respiratory tract infections (34.2%) or pneumonia (17%).

We found a statistically significant ICC between actual weight and EW r = 0.926 (P < 0.001) (fig. 1), although the mean was significantly lower when calculated with Chumlea's equations, 61.46 (SD 13.08) *vs* 54.05 (SD 11.88) (table I).

The ICC between BMI and EBMI and between MNA and EMNA were also statistically significant, r = 0.910 (P < 0.001) and r = 0.982 (P < 0.001), respectively. Mean estimated parameters were significantly lower than real parameters: 25.36 (SD 5.17) *vs* 22.3 (SD 4.61), and 23.3 (SD4.33) *vs* 22.73 (SD 4.43), respectively (table I).

We found statistically significant differences when comparing patients categorized according to BMI and EBMI. BMI was underestimated in the majority of patients using EBMI: 86.2% of patients with overweight were classified as normal; 16.7% of obese were categorized as normal; 58.3% of obese were classified as overweight and 21.2% of patients with normal BMI were classified as underweight (P < 0.001). BMI was overestimated in a few patients: 3.4% of patients with overweight were classified as obese (table II).

Comparing MNA and EMNA classifications we found that estimated MNA detected 100% of patients malnourished and 96% of those at risk of malnutrition. We also noted that with Chumlea's equations 11.8% of patients were classified as at risk of malnutrition when by standard measures they would have been classified as no malnutrition, and 4% of patients were classified as having malnutrition when they should have been considered at risk of malnutrition (P < 0.001) (table III).

Discussion

This study shows that Chumlea's equations for weight can be used to assess nutritional status in elderly patients. Although actual weight was underestimated, the equations could serve to perform screening for malnutrition in non-ambulatory patients who would probably benefit

Table I
Shows the differences with actual weight, and weight estimated using Chumlea's equations; between BMI[1] and estimated BMI; and MNA[2] and estimated MNA

	Actual	*Chumlea's equations*	*ICC[4]*	*P*
Mean weight	61.46 (SD[3] 13.08)	54.05 (SD 11.88)	0.926*	< 0.001
Mean BMI	25.36 (SD 5.17)	22.30 (SD 4.61)	0.910*	< 0.001
Mean MNA	23.30 (SD 4.33)	22.73 (SD 4.43)	0.982*	< 0.001

[1]Body Mass Index; [2]Mini Nutritional Assessment test; [3]Standard deviation; [4]Intraclass correlation coefficient.
*P < 0.001.

Table II
Categories according BMI[1]. Differences between real BMI and estimated BMI ($p < 0.001$)

	Estimated BMI				
	Underweight	*Normal*	*Overweight*	*Obese*	*Morbid obese*
BMI					
Underweight	7 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Normal	7 (21.2%)	26 (78.8%)	0 (0%)	0 (0%)	0 (0%)
Overweight	0 (0%)	25 (86.2%)	3 (10.3%)	1 (3.4%)	0 (0%)
Obese	0 (0%)	2 (16.7%)	7 (58.3%)	3 (25%)	0 (0%)
Morbid obese	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (100%)

[1]Body Mass Index.

Table III
Categories according MNA[1]. Differences between real MNA and estimated MNA ($p < 0.001$)

	Estimated MNA		
	No malnutrition	*Risk of malnutrition*	*Malnutrition*
MNA			
No malnutrition	45 (88.2%)	6 (11.8%)	0 (0%)
Risk of malnutrition	0 (0%)	24 (96%)	1 (4%)
Malnutrition	0 (0%)	0 (0%)	6 (100%)

[1]Mini-nutritional assessment test.

from nutritional intervention. The only alternative method to calculate weight in these patients is chair scales or hoist scales. These methods have been used in a few studies, such as in that by Pichard et al. about lean body mass depletion at hospital admission and its association with an increased length of stay,[12] and in two other studies by Bruce et al.[13] and Espaulella et al.[14] about nutritional supplementation after hip fracture. However, chair and hoist scales are expensive and therefore not readily available in many centers, especially in underdeveloped and developing countries. Another way to calculate weight can be by guessing patients' weight as clinicians in a Spanish study by Cereceda Fernández et al. did to detect malnutrition among elderly patients at admission to hospital.[15] This method may give an approximate idea but it is not reliable. Self-reported BMI values can also be unreliable as they tend to overestimate real BMI values at the low end of the scale and underestimate values at the high end.[16]

The interest of the present study is that we used weight measured using Chumlea's equations to calculate BMI and MNA, two useful tools in nutritional assessment that can not be calculated without knowing an individual's weight. Although results obtained with Chumlea's equations underestimated real BMI and MNA, we were able to identify malnourished patients. Other methods, such as a more thorough dietary anamnesis or analytical data, could then be used to reach a more accurate diagnosis.

Other authors have considered the problem of calculating weight in non-ambulatory elderly and other attempts have been made to find predictive equations to calculate weight from body parameters. Rabito et al. created equations to estimate weight using arm, calf and abdominal circumference, subscapular skinfold and knee height. They found a good correlation between actual weight and their EW when they applied their equation to 100 patients but they did not state whether the mean of the two weights was similar.[17] We found only one other study that used Chumlea's equations. A group from Mexico, Bernal-Orozco et al., studied elderly women in hospitals and nursing homes and compared EW obtained by the Chumlea's equations with EW calculated by their own equations. In the nursing homes, both types of equation overestimated actual weight, but the mean difference was smaller using their own equations than using Chumlea's equations. The authors suggested that equations created in North America may not be as accurate in other populations.[18]

This study has both strengths and limitations. The main strength is the effectivity of a simple tool, Chumlea's equations, to calculate weight for BMI and MNA. The main limitation is the relatively small sample size resulting from the strict inclusion criteria which excluded patients with moderate or severe dementia.

Conclusion

Although Chumlea's equations underestimated actual weight they showed a statistically significant ICC between actual weight and estimated weight. These equations can be useful to detect malnutrition in hospitalized elderly patients as long as this underestimation is taken into consideration.

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