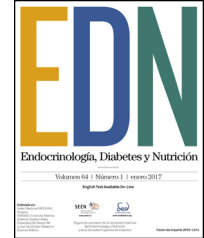




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ORIGINAL ARTICLE

Validation of equations and proposed reference values to estimate fat mass in Chilean university students[☆]

Rossana Gómez Campos^{a,b}, Jaime Pacheco Carrillo^c,
Alejandro Almonacid Fierro^a, Camilo Urrea Albornoz^d, Marco Cossío-Bolaños^{a,e,f,*}

^a Universidad Autónoma de Chile, Talca, Chile

^b Facultad de Educación Física, Universidad Estadual de Campinas, Sao Paulo, Brazil

^c Departamento de Ciencias de la Educación, Profesor de Educación Física, Universidad del Bio Bio, Chillán, Chile

^d Escuela de Kinesiología, Facultad de Salud, Universidad Santo Tomás, Talca, Chile

^e Departamento de Ciencias de la Actividad Física, Universidad Católica del Maule, Talca, Chile

^f Instituto de Deporte Universitario, Universidad Nacional de San Agustín, Arequipa, Peru

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KEYWORDS

Fat mass;
Equations;
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Abstract

Objectives: (i) To propose regression equations based on anthropometric measures to estimate fat mass (FM) using dual energy X-ray absorptiometry (DXA) as reference method, and (ii) to establish population reference standards for equation-derived FM.

Material and methods: A cross-sectional study on 6713 university students (3354 males and 3359 females) from Chile aged 17.0 to 27.0 years. Anthropometric measures (weight, height, waist circumference) were taken in all participants. Whole body DXA was performed in 683 subjects. A total of 478 subjects were selected to develop regression equations, and 205 for their cross-validation. Data from 6030 participants were used to develop reference standards for FM. Equations were generated using stepwise multiple regression analysis. Percentiles were developed using the LMS method.

Results: Equations for men were: (i) $FM = -35,997.486 + 232.285 * Weight + 432.216 * CC$ ($R^2 = 0.73$, $SEE = 4.1$); (ii) $FM = -37,671.303 + 309.539 * Weight + 66,028.109 * ICE$ ($R^2 = 0.76$, $SEE = 3.8$), while equations for women were: (iii) $FM = -13,216.917 + 461,302 * Weight + 91.898 * CC$ ($R^2 = 0.70$, $SEE = 4.6$), and (iv) $FM = -14,144.220 + 464.061 * Weight + 16,189.297 * ICE$ ($R^2 = 0.70$, $SEE = 4.6$). Percentiles proposed included p10, p50, p85, and p95.

Conclusion: The developed equations provide valid and accurate estimation of FM in both sexes. The values obtained using the equations may be analyzed from percentiles that allow for categorizing body fat levels by age and sex.

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* Corresponding author.

E-mail address: mcossio1972@hotmail.com (M. Cossío-Bolaños).

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PALABRAS CLAVE

Masa grasa;
Ecuaciones;
Jóvenes
universitarios;
Percentiles

Validación de ecuaciones y propuesta de valores referenciales para estimar la masa grasa de jóvenes universitarios chilenos

Resumen

Objetivos: a) Proponer ecuaciones basadas en índices antropométricos para estimar la masa grasa (MG) utilizando como método de referencia la absorciometría de rayos X de doble energía (DXA), y b) establecer normas de referencia para valorar la MG estimada.

Material y métodos: Estudio transversal en 6.713 jóvenes universitarios (3.354 hombres y 3.359 mujeres) de Chile con un rango de edad comprendido entre los 17,0 y los 27,0 años. Se obtuvieron medidas antropométricas (peso, talla y perímetro cintura) en todos los participantes. Se realizó una DXA en 683 participantes. Un total de 478 sujetos fueron seleccionados para desarrollar ecuaciones de regresión y 205 para su validación cruzada. Los percentiles se desarrollaron con los datos de 6.030 participantes. Para generar las ecuaciones se utilizó el análisis de regresión múltiple por pasos. Para desarrollar los percentiles se utilizó el método LMS.

Resultados: Las ecuaciones para hombre fueron: 1) $MG = -35.997486 + 232.285 * \text{Peso} + 432.216 * CC$ ($R^2 = 0.73$ EEE = 4.1); 2) $MG = -37.671303 + 309.539 * \text{Peso} + 66.028109 * ICE$ ($R^2 = 0.76$ EEE = 3.8) y para mujeres fueron: 3) $MG = -13.216917 + 461.302 * \text{Peso} + 91.898 * CC$ ($R^2 = 0.70$ EEE = 4.6) y 4) $MG = -14.144220 + 464.061 * \text{Peso} + 16.189297 * ICE$ ($R^2 = 0.70$ EEE = 4.6). Los percentiles propuestos son: p10 p50 p85 y p95.

Conclusión: Las ecuaciones desarrolladas proporcionan predicciones válidas y exactas para estimar la MG de jóvenes universitarios de ambos sexos. Los valores obtenidos mediante la aplicación de estas ecuaciones pueden ser analizados a partir de percentiles que permiten categorizar los niveles de adiposidad corporal por rango de edad y sexo.

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Introduction

There is growing interest in establishing methods for categorizing fat mass (FM) and its variations,^{1,2} since the generally used excess body fat markers are subject to limitations.³

Adipose tissue has a complex regulatory function and exerts multiple effects upon lean mass.² Excess FM is associated with an increased risk of cardiovascular diseases, type 2 diabetes, arterial hypertension and other disorders.⁴ In addition, reduced muscle mass has been related to fractures in children, adolescents and adults.^{5,6}

Chile is the Latin American country with the highest overweight and obese rates in the general population.^{7,8} Moreover, studies have described changes in the distribution of FM and in certain cardiovascular risk factors in recent years among young populations.^{9,10} For example, Cossio-Bolaños et al.¹⁰ reported a significant increase in waist circumference, with no variations in the body mass index (BMI), for all BMI ranges in Chilean university students during the period 2007–2014.

Recently, the CDC-2012¹¹ has proposed a number of anthropometric indicators for evaluating adiposity, including the BMI, skin folds and waist circumference, for all stages of life. These international references make it possible to compare and monitor health throughout the world, but may be subject to limitations, since there are important genotypic, phenotypic and sociocultural differences between regions and countries.

Many governments and United Nations agencies rely on international references for measuring population wellbeing, defining health-related policies, planning interventions, and monitoring their efficacy.¹² However, the development of equations to estimate FM in university students based on anthropometric variables and indicators could be useful as a

complement to other adiposity indices and/or for monitoring changes in body composition after a given intervention. Furthermore, they would allow for the definition of regional reference standards according to age and gender.

The present study was carried out with the following objectives: (a) to propose regression equations for estimating FM and analyze their cross-validity, using dual-energy X-ray absorptiometry (DXA) as the reference method; and (b) to establish reference standards for assessing FM from regression equations based on anthropometric variables and indicators.

Methods**Study design, sample and participants**

A cross-sectional study was made of 6713 students (3354 males and 3359 females) from three universities (private, semi-private and public, respectively) in the region of Maule, Chile. The age range was 17.0–27.0 years. The capital of the region is Talca, located 270 km south of the capital, Santiago de Chile. The economy of the region is based on agriculture and cattle raising, as well as wine production.

Of the 6713 participants, 683 were evaluated by whole body DXA (10.2% of the global study sample); 478 of these subjects were then selected for the development of regression equations and 205 for cross-validation. The data of the remaining 6030 participants were used for the development of the percentiles. Fig. 1 shows the distribution and organization of the study sample.

All students of ages above and under the established range were excluded, as were those who did not give their informed consent, those failing to report on the day of the

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