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Research Paper

Percentage of body fat in adolescents with Down syndrome: Estimation from skinfolds

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Abstract

Background: Adolescents with Down syndrome (DS) have a unique morphology and body shape, and this needs to be taken into account when assessing body fat percentage (BF%).

Objective: To develop a predictive equation from anthropometric variables (skinfolds) for estimating BF% in adolescents with DS.

Methods: Twenty-three adolescents with DS (7 girls, 16 boys) participated in the study; seven skinfold measurements were taken (biceps, triceps, subscapular, supraspinale, abdominal, front thigh, and medial calf), circumferences and diameters were measured following ISAK recommendations. Total body volume (and then body density) was measured with air displacement plethysmography (ADP); BF% was then calculated. Correlation between anthropometry data and BF% by ADP, and stepwise regression analyses were applied to develop a specific prediction equation.

Results: All the skinfolds, BMI, hip, waist and thigh circumferences correlated with BF% and were included in the regression analysis; sex and triceps were added into the model ($R^2 = 0.89$, $p < 0.05$). Therefore the proposed equation computed as follows: $BF\% = (0.97\ TR) - (8.869 \cdot SEX) + 15.6$ where *TR* is triceps skinfolds (mm) and *SEX* is equal to 0 for female and 1 for male.

Conclusions: The proposed prediction equation is recommended for the assessment of BF% in adolescents with DS as it is the only one specifically developed and validated in this unique population. It is a cheap, reliable and accessible method that removes the need for use of expensive equipment.

Keywords: Trisomy 21; Body composition; Bod-Pod; ISAK; Fat mass

Children and adolescents with Down syndrome (DS) have a unique body composition, different than their counterparts without DS.[1,2] Overall, adolescents with DS have shown different body fat (BF) distribution and a higher percentage BF (BF%),[3] among with other characteristics in their shape and somatotype.[4]

Despite cardiovascular complications are not among the most common causes of death in persons with DS[5] and in fact that they have lower cardiovascular risk factors than persons with other types of intellectual disability.[6]

Nevertheless, high BF% and other factors associated with obesity may result in future cardiovascular complications.[7,8]

Assessing BF% at the individual level needs to be accurate enough to provide data that can be used for physicians (drugs/exercise prescription), Special Olympic coaches (training design), registered dieticians (diet preparation) or researchers (studies). Some methods and devices for the assessment of BF% provide very accurate values such as dual energy X-ray absorptiometry (DXA) or air displacement plethysmography (ADP) but are not feasible or useful when large populations need to be measured, when economic resources are limited or in clinical settings. Other field-based methods such as anthropometry are widely used for the assessment of large populations or when the economic sources are limited, however, the main issue when using anthropometry for the

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assessment of BF% is the choice of the correct anthropometric equation. Several prediction equations have been developed over the last few decades in different populations using different anthropometric variables such as skinfolds, circumferences and diameters. Durnin and Rahaman (1967),[9] Brook (1971),[10] Durnin and Womersley (1974),[11] Johnston et al (1988)[12] or Slaughter et al (1988)[13] along others have been widely used to predict total body density (TBD) or BF% from skinfolds in adolescents without disability. These equations were developed using reference methods such as underwater weighing, DXA or ADP.

Previous studies have assessed the BF% in persons with DS using prediction equations developed in non-disabled populations,[14,15] which as previously stated is not completely due to the unique body shape and morphology of persons with DS. Prediction equations should be selected based on specific characteristics of the measured participants.[16] Rimmer et al in 1987 studied the accuracy of prediction equations in adults with intellectual disability[17] and recently, González-Agüero et al evaluated this in adolescents with DS.[18] Authors from the latter study concluded that the equation of Slaughter et al[13] seemed to be the most accurate for estimating BF% in adolescents with DS; nevertheless, a specific equation developed in this determined population would improve the accuracy of it. In fact, Casey[19] concluded in a timely review that there is a need to find population-specific prediction equations that are suitable for individuals with intellectual disabilities. Also, Usera et al[20] demonstrated a lack of validity in the use of three field-based methods (Jackson's, Lohman's and Kelly & Rimmer's prediction equations) to assess the body composition of individuals with DS indicating that none of them adequately estimated BF%. They encouraged the development of equations that can assess body composition in individuals with DS in a feasible way.

Taking these results and observations into consideration, the aim of the present study was to develop a prediction equation with anthropometric variables for the assessment of BF% in adolescents with DS using ADP as a reference method.

Methods

Participants

A total of 23 adolescents (7 girls/16 boys) with DS living at home and aged 12−18 years old were recruited from three different schools and institutions in Aragón (Spain). Before the start of the study institutions were contacted to deliver a briefing session with parents and offering the opportunity to participate in the study. Both parents and adolescents were informed concerning the aims and procedures of the study, as well as the possible risks and benefits derived. An informed consent was obtained from the parents of each participant and verbal assent from the participants.

The study design, protocol and consent forms were performed in accordance with the Helsinki Declaration of 1964 (revised in Fortaleza, 2013) and were reviewed and approved by the Research Ethics Committee of the Government of Aragon (CEICA, Spain) [C.I. PI10/026]. The research study was registered in a public database [NCT02380638].

Anthropometry

Some of the following methodological considerations have been described in detail elsewhere.[18] All subjects were measured with a stadiometer without shoes and minimal clothing to the nearest 0.1 cm (SECA 225, SECA, Hamburg, Germany), and weighed to the nearest 0.1 kg (SECA 861, SECA, Hamburg, Germany). Body mass index (BMI) was calculated as weight (in kilograms) divided by squared height (in meters). A complete anthropometry was performed following the recommendations of the International Society for the Advance of the Kinanthropometry (ISAK).[21] Seven skinfold measurements were taken (biceps, triceps, subscapular, supraspinale, abdominal, front thigh, and medial calf) with a skinfold calliper (Holtain Ltd. Crymmych, UK) to the nearest 0.2 mm; six circumferences were measured (arm relaxed, arm flexed, waist, hip, thigh and calf) with a Rosscraft anthropometric tape (Rosscraft, Canada), and two bone biepicondylar breadths were also measured (humerus and femur) with a Rosscraft calliper (Rosscraft, Canada). A certified level 2 ISAK (i.e. qualification that requires standardized measurement and a very low technical error of measurement) anthropometrist collected all data.

Air displacement plethysmography

Raw body volume (total body volume + thoracic gas volume) was evaluated with the BOD POD® MODEL 2000A using software version 2.3 (Body Composition System; Life Measurement Incorporated, Concord, CA) as previously described.[22] The BOD POD software allows for the thoracic gas volume (TGV) to be estimated using equations developed in adults by Crapo et al[23] However, in this study, TGV was calculated according to the child-specific TGV prediction equations for ADP proposed by Fields et al.[24] TBD from the BOD POD was calculated with the following equation $TBD = M/(BVraw + 0.40TGV - SAA)$. Where M is the mass of the subject in kg, BVraw is the raw body volume in L, and SAA is the surface area artifact in L automatically computed by the computer software. Body fat was then calculated by using the pediatric version of Siri's equation,[25] which was validated in children and adolescents from 1 to 17 years, and modified by Silva et al[26] and adapted form Wells et al.[27] The same fully trained technician performed all test. Before each test a calibration process was performed using the empty chamber and a 50.378 L calibration cylinder. All study subjects wore the same bathing cap provided by our laboratory. Subjects were weighed to the nearest 0.1 kg wearing their own underclothing,