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Physical performance measures in screening for reduced lean body mass in adult females with obesity

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Abstract *Background & aims:* Little is known about the reduction of lean body mass (LBM) in obesity, or how to identify it in standard clinical settings. We therefore aimed to assess the prevalence of low LBM in adult females with obesity, and to identify the reliability of simple tools for its screening in this population.

Methods and Results: Dual-energy X-ray absorptiometry (DXA) body composition assessment was used to categorise 147 female participants with obesity as with or without low LBM, according to the new definition that takes into account both appendicular lean mass (ALM) and body mass index (BMI)—ALM/BMI <0.512. Participants were also administered the six-minute walking test, handgrip-strength test and 4-metre gait-speed test.

Of the sample of 147 participants, 93 (63.3%) met the criteria for reduced LBM. Stepwise multivariate logistic regression analysis showed that the six-minute walking test was the only independent test associated with low LBM (OR = 0.992, 95%CI 0.987–0.998). Receiver operating characteristic (ROC) curve analysis found that the discriminating cut-off points of the tests considered were 470 m, 3.30 s (gait speed = 1.2 m/sec) and 23.5 kg respectively; the 4-metre gait-speed test seems to provide the best balance of sensitivity and specificity, and the greatest discriminatory power at 90% sensitivity.

Conclusions: Treatment-seeking adult females with obesity display a great prevalence of reduced LBM. The six-minute walking test was the only independent test associated with low LBM, but the 4-metre gait-speed test seems to be the most accurate functional test for screening for this condition in that population.

Introduction

Although considerable research has been devoted to assessing body composition in obesity [1], little data has been published on the reduction in lean body mass (LBM) in this population [2]. This is an important shortcoming, as in other populations LBM deficit is associated with several serious medical repercussions, such as low vitamin D [3],

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low bone mineral density and fractures [4,5], reduction in physical fitness [6], longer hospitalization [7], and high rates of mortality [8].

Obesity is a condition defined as an excessive accumulation of fat in adipose tissue, and is associated with an increased risk of chronic diseases, disability and mortality [9]. The coexistence of obesity and reduced LBM may synergistically increase their respective effects on metabolic disorders, cardiovascular diseases and mortality [10,11]. Indeed, recent reports indicate that LBM reduction in patients with obesity is related to an increase in insulin resistance and inflammatory markers [10,11]. Therefore, the identification of LBM and the application of potential therapeutic strategies (e.g. physical activity interventions, high-protein diets, protein supplements etc.) focused on limiting LBM deterioration in patients with obesity is of critical importance [12–14].

It is important to note that the definition of reduced LBM in obesity based only on lean mass— without accounting for body mass—may not be accurate, because patients with obesity tend to have a relatively large lean mass. Hence the criteria for low LBM based solely on this parameter may not be met in these individuals, in whom the prevalence may therefore be greatly underestimated [15]. For this reason we set out to assess the prevalence of LBM reduction in treatment-seeking adult females with obesity using a new definition proposed by the Foundation for the National Institutes of Health (FNIH) Sarcopenia Project; this definition, in addition to appendicular LBM, also takes into account the body mass index (BMI) [16]. Moreover, we also endeavoured to evaluate the reliability of simple tools (i.e. muscle strength and physical performance tests) that could be used as a preliminary screen for low LBM in this population before resorting to more costly, albeit more reliable, methods such as dual x-ray absorptiometry (DXA).

Methods

Participants were recruited at two sites from consecutive referrals by family doctors to the rehabilitative treatment programmes for obesity at the Villa Garda Hospital Department of Eating and Weight Disorders Inpatient Unit and the University of Verona Department of Medicine Outpatient Clinic during the years 2015–2016. Patients were eligible for this study if they were female, aged $\geq$20 years, with a BMI $\geq$30.0 kg/m^2 and at least one weight-loss-responsive comorbidity (i.e., type 2 diabetes, cardiovascular disease, sleep apnoea, severe joint disease, two or more risk factors), as defined by the Adult Treatment Panel III [17]. Patients were excluded if they were male, pregnant or lactating, taking medications that affect body weight, or had medical comorbidities associated with weight loss, or severe psychiatric disorders. The study design was reviewed and approved by the Institutional Review Boards of Villa Garda Hospital and the University of Verona, and all participants gave informed written consent.

All data were collected on the second day of admission to the respective programmes. Specifically, body weight, height and waist circumference were measured, using medical weighing scales (Seca Digital Wheelchair Scale Model 664) and a stadiometer (Wall-Mounted Mechanical Height Rod Model 00051A; Wunder), respectively. Participants wore lightweight clothing and no shoes during these measurements, and their BMI was determined according to the standard formula of body weight (kg) divided by height (m) squared. Waist circumference was measured to the nearest 0.1 cm at the level of the iliac crest while the subject was breathing normally.

Body composition was assessed by DXA (Prodigy Primo Lunar, A223040501, General Electric Company, Madison. WI 53707-7550, USA-EnCORE TM 2009 (v13.31) software), calibrated daily prior to measurement as a quality control, according to a procedure described in detail elsewhere [18]. The total fat and lean mass percentages and the appendicular lean mass (ALM) were calculated using the standard formulas [18]. Low LBM was defined as ALM/BMI of less than 0.512 [16].

Muscle strength and physical performance were assessed by means of the six-minute walking test [19], handgrip-strength test [20], and 4-metre gait-speed test [21], respectively, according to international guidelines. Specifically, the six-minute walking test was performed in a corridor marked with tape on the floor every 2 m and at the start and finishing points. Pulse, respiratory rate, and oxygen saturation were measured before the start and at the end of the test. Patients were instructed to walk as fast as possible, and were allowed to stop or rest during the test if necessary [19]. The handgrip-strength test was performed on both hands using a calibrated Smedley Spring Dynamometer, and the maximum value (kg) was recorded [20]. The 4-metre gait-speed test was performed on a flat course (in an clinic assessment room) with 4 m marked out with tape. A walk was demonstrated to each participant prior to starting the test, but participants themselves did not perform a practice walk. The participant was positioned with the toes just touching the start line. Timing with a stopwatch started when the participant began to move, and was stopped when the participant's lead foot completely crossed the 4-m line [21]. General psychological distress was also assessed on a Global Severity Index (GSI), calculated from Brief Symptom Inventory (BSI) scores [22].

Statistical analysis

The distribution of continuous variables was tested using the Kolmogorov–Smirnov and Shapiro–Wilks tests. Weight, BMI, waist circumference, body composition variables and physical performance variables were normally distributed, but age and global BSI score were not. A comparison (age, weight and BMI) between the two recruitment sites indicated that patients recruited at the Villa Garda Hospital Department of Eating and Weight Disorders Inpatient Unit were older and had a higher weight and BMI with respect to patients recruited at the University of Verona Department of Medicine Outpatient

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