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Original article

Exploration of the protein requirement during weight loss in obese older adults

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SUMMARY

Rationale: Currently there is no consensus on protein requirements for obese older adults during weight loss. Here we explore the potential use of a new method for assessment of protein requirements based on changes in appendicular muscle mass during weight loss.

Methods: 60 obese older adults were subjected to 13 wk weight loss program, including hypocaloric diet and resistance training. Assessment of appendicular muscle mass was performed by DXA at baseline and after 13 wk challenge period, and the difference calculated as muscle mass change. Protein intake (g/kg body weight and g/kg fat free mass (FFM)) at 13wks was used as marker of protein intake during 13 wk period. 30 subjects received 10 times weekly 20 g protein supplement throughout the 13 week hypocaloric phase which is included in the calculation of total protein intake. Receiver operating characteristic (ROC) curve analysis was used to explore the optimal cutoff point for protein intake (g/kg) versus increase in appendicular muscle mass of more than 250 g over 13 wks (y/n). Subsequently, logistic regression analysis was performed for protein intake cutoff and muscle mass accretion, adjusted for sex, age, baseline BMI, and training compliance.

Results: ROC curve analysis provided a protein intake level per day of 1.2 g/kg bw and 1.9 g/kg FFM as cutoff point. Presence of muscle mass accretion during 13 wk challenge period was significantly higher with protein intake higher than 1.2 g/kg bw (OR 5.4, 95%CI 1.4–20.6, $p = 0.013$) or higher than 1.9 g/kg FFM (OR 8.1, 95%CI 2.1–31.9, $p = 0.003$). Subjects with a protein intake higher than 1.2 g/kg had significantly more often muscle mass accretion, compared to subjects with less protein intake (10/14 (72%) vs 15/46 (33%), $p = 0.010$). For 1.9 g/kg FFM this was 70% vs 28% ($p = 0.002$).

Conclusion: This exploratory study provided a level of at least 1.2 g/kg body weight or 1.9 g/kg fat free mass as optimal daily protein intake for obese older adults under these challenged conditions of weight loss, based on muscle mass accretion during the challenge.

Trial registration: Dutch Trial Register under number NTR2751.

1. Introduction

The prevalence of obesity among older adults is increasing [1]. Obesity is related to insulin resistance, high blood pressure and dyslipidaemia, which are metabolic risk factors for cardiovascular diseases and diabetes mellitus [2]. In addition, obesity plays an important role in non-fatal physical disability in older adults [3]. Weight loss leads to metabolic and functional benefits [4]. However, a potential drawback of weight loss in older adults is the accompanying loss of skeletal muscle mass [5]. This loss of muscle mass may, in the long term, accelerate the development of sarcopenia [6,7]. Reduction in muscle mass and strength impairs physical function and activities of daily living and is associated with an increased risk of falling and physical disabilities [6–8]. Thus, although obese older adults may benefit from weight loss, therapy should focus on minimizing the loss of muscle mass to preserve independence and quality of life [6].

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The protein requirements for adults of 0.83 g/kg/d has been established based on regression analysis of individual nitrogen balances on very different levels of protein intake [9,10]. This level of protein intake is suggested to be used for older adults as well as obese people. There are no specific recommendations for obese older adults during weight loss. Rand et al. [11] provided the basis for the 2007 recommendations and show that the protein requirement of elderly (>67 years) may have been higher than young (<40 years), but there was insufficient evidence for a higher protein recommendations. Recently two recommendations were published advising a protein intake of 1.0–1.2 g/kg for older adults [12,13]. Older adults had not been studied for protein requirements when obese, nor during weight loss. High protein intake during weight loss in middle aged obese adults seems to preserve muscle mass during weight loss therapy [14–16].

To our knowledge, there have been no studies to explore the protein requirement in obese older adults during weight loss. Therefore we aimed to define the optimal protein intake level in obese older adults during weight loss, based on the positive change in appendicular skeletal muscle mass, or in other words muscle mass accretion.

2. Methods

2.1. Subjects

This is a posthoc analysis of data from a double blind randomized controlled trial. The RCT was a 13-week voluntary weight loss trial with hypocaloric feeding and resistance training, as described before [17]. Subjects were 55 years and older with a BMI >30 kg/m^2, or a BMI >28 kg/m^2 combined with a waist circumference >88 cm in women or >102 cm in men. A full description of the eligibility criteria is online available in the Dutch Trial Register (NTR2751). The study was approved by the Medical Ethics Committee of the VU University Medical Center Amsterdam (2010/280). The study took place from March 2011 until June 2012 at the Amsterdam University of Applied Sciences in The Netherlands.

2.2. Intervention

All subjects followed a hypocaloric diet of 600 kcal below estimated energy needs as advised by the current Dutch guidelines for the treatment of obesity [18]. Energy needs were based on the measured resting energy expenditure (indirect calorimetry; Vmax Encore n29, Viasys Healthcare, Houten, Netherlands) multiplied by the physical activity level (estimated by a three-day physical activity record).

The resistance exercise program was performed 3 times per week for 1 h under supervision of a qualified trainer for a period of 13 weeks. The training started with a 10-min warming up on a bicycle ergometer followed by 3 sets of 20 repetitions of the following 10 exercises: lateral pull down, arm curl, high row, shoulder press, leg curl, horizontal row, chest press, arm extension, leg extension and leg press. The number of repetitions was stepwise reduced to 12 repetitions and the weights were increased to the ability of the participants. The training ended with 5-min cooldown on a bicycle ergometer.

Subjects were asked to consume 10 servings of the study product per week throughout the 13-week intervention period. Subjects consumed one serving daily, just before breakfast. The other three servings were consumed immediately after exercise training (3 times/wk). The protein product was a high whey protein, leucine-enriched nutritional supplement containing 150 kcal per serving in a volume of 150 mL, 20 g whey protein, 3 g total leucine, per serving (for further details see ref 17). The control product contained no protein. Supplements were accounted for within the dietary advice as well as total caloric and protein intake.

2.3. Protein intake

Daily dietary intake was collected by a 3-day food record at baseline, and after 13 weeks of intervention. At the study visits food records were checked for completeness and additional information was obtained about unclear items or amounts. Total energy and macronutrient intakes were calculated using a computerized Dutch Food Composition Table [19]. Protein intake as observed at 13 weeks, and expressed as g/kg body weight or g/kg fat free mass, was used as the protein intake level most representative for the whole intervention period. Half the subjects received 10 times weekly 20 g protein supplement, or the actual intake (compliance), which is included into total protein intake.

2.4. Muscle mass accretion

Appendicular muscle mass were measured with dual-energy x-ray absorptiometry (DXA; GE Lunar Prodigy/DPX-NT, the Diagnostic Centre Amsterdam, The Netherlands) at baseline and after 13 weeks of intervention. To limit within-subject variation DXA-scans were performed at the same time of day during both visits. Appendicular muscle mass was defined as the sum of the lean mass (without bone) of arms and legs. The change in appendicular muscle mass over the 13-wk intervention period was dichotomized using a cutoff of +250 g, therefore up to this level no change or muscle wasting was assumed, while higher values were assumed to indicate muscle mass accretion. Fat free mass (FFM) was also derived from the DXA measurement, and included lean body mass with bone.

2.5. Statistical analysis

Subject characteristics and baseline values were compared between groups using an independent samples t-test or the Fisher Exact test. Receiver operating characteristic (ROC) curve analysis was used to explore the optimal cutoff point for protein intake (g/kg body weight or g/kg FFM) based on muscle mass accretion of more than 250 g over 13 wks (y/n). Protein intake levels were tested between 0.8 and 1.6 g/kg with 0.05 increments, and between 0.8 and 2.5 g/kg FFM with 0.1 increments. Logistic regression analysis was used to confirm the impact of protein intake on muscle mass accretion. Logistic regression analysis was performed with muscle mass accretion (y/n) as independent variable, with protein intake cutoff as dependent variable, adjusted for sex, age, baseline BMI, and training compliance. The effect of a protein intake level of more than 1.2 g/kg bw was also evaluated against 13-wk change in muscle mass as continuous variable (kg). SPSS 20 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. A $p < 0.05$ was considered statistically significant.

3. Results

In total, 80 subjects were randomized in the trial, and for 60 subjects muscle mass change could be assessed. These subjects were equally (30/30) distributed over intervention and control group. Table 1 shows overall mean intake of protein is 89.7 ± 27.6 g/d (range 39–170 g/d), and 0.98 ± 0.29 g/kg per day (range 0.41–1.77 g/kg), and 20.8 ± 4.1% of energy intake as protein (range 13.4–30.6 %).

ROC analysis provided protein intake level per day of 1.2 g/kg bw and 1.9 g/kg FFM as cutoff points. Both 1.0 and 1.2 g/kg bw cutoffs were plausible based on the ROC curve analysis, therefore logistic

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