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Original Article

Nutritional status and energy expenditure after a programme of nutrition education and combined aerobic/resistance training in obese women

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SUMMARY

Background & aims: we investigated changes in markers of nutritional status and energy expenditure after a programme of nutrition education and combined aerobic/resistance training in obese women and distinguished these changes in association with the loss, or not, of body weight.
Methods: Obese women (30–50 years) participated in a nutritional education and physical training programme for four months. Variables analysed: anthropometric measures, body composition (by DEXA) and some biochemical markers of nutritional status (leptin, IGF-I, pre-albumin, albumin, hemogram) and of risk of chronic diseases (blood glucose, total cholesterol, HDL, LDL, triacylglycerol).
Results: Body mass changes were from −6.0 to +4.0 Kg. All women decreased waist circumference, monocyte count and leptin, changes associated with improved health. In approximately 20% of the women, most of the markers of protein nutritional status decreased below the normal range, probably due inadequate dietary protein intake. The women who did not lose weight presented a reduction in resting energy expenditure and increased their fat intake from the diet.
Conclusions: The programme resulted in the improvement of several markers of chronic diseases; at the same time, variables related to protein nutritional status worsened. None of these observations appeared to be related to the fact of losing, or not, body weight. It may be suggested that obese individuals who improve their level of physical exercise increase their need for protein, probably above the current recommendation.

1. Introduction

The consequences of obesity are well known, and efforts are being conducted to prevent or control this global epidemic.[1] Although there is no consensus on the most effective strategy to treat and/or to prevent obesity, food restriction and increased physical activity are the most commonly adopted approaches.[2]

With respect to food restriction, many concerns surround this strategy: the difficulty for individuals to adopt a new dietary plan, the physiological adaptations to low energy intake and even the risk of promoting eating disorders.[2,3] Conversely, physical activity, in particular aerobic exercise, despite promoting cardiorespiratory fitness,[4] has varied effectiveness in producing weight loss.[5] King et al.[2] reported that individual variability in losing body weight could be due to compensatory responses to exercise-induced increase in energy expenditure, or may be related to behavioral and/or physiological changes.

Considering that both physical activity and nutrition interventions have weaknesses, a good approach is to combine these strategies, avoiding excessively restrictive diets and excessively demanding exercise programme. As such, we hypothesized that a nutrition education programme could be better than the prescription of restrictive diets. Nutrition educational programmes recommend that subjects should make their own healthy food choices, aiming to enhance individual autonomy.[6]

Despite the strategy adopted, it is important to note that obesity management interventions should take the maintenance and/or recovery of the individual's nutritional status into consideration.

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Nutritional status can be defined as the balance between the intake of nutrients by the organism and the expenditure of these in the processes related to body maintenance: growth, reproduction, immune system and activities performed. A comprehensive approach to nutritional status assessment includes anthropometric measurements, assessment of biochemical markers, physical examination and dietary evaluation. In addition, energy expenditure can be included in these analyses.[7] Generally, studies that evaluate nutrition and physical activity programmes tend to only assess changes in fat mass (FM) and lean mass (LM). Considering the coverage of nutritional status assessment, these measurements may be considered to be incomplete or unsatisfactory.

With regard to the principal concerns surrounding exercise, weight loss and nutritional status, some controversies exist as to the best exercise method that should be employed. Resistance training is capable of enhancing muscle mass[8] and, as a consequence, resistance training can improve nutritional status, since muscle mass is an important marker of protein nutritional status.[7] Also, it has been hypothesized that one of the benefits of aerobic physical exercise is the reduction of body fat, which in turn contributes to decrease inflammation and, consequently, improve nutritional status. However, recent studies[9] have questioned the efficacy of moderate intensity exercise in the ability of reducing inflammation, suggesting that more intensive exercise may be necessary. Therefore, we can infer that combining two methods of exercise (aerobic and resistance) is a good option when aiming to improve nutritional status.

As such, this study aims to investigate changes in markers of nutritional status and energy expenditure after a nutrition education and a combined aerobic/resistance training programme in obese women. Considering the known individual variability in weight loss responses, an additional aim was to distinguish nutritional status changes, in association with the loss, or not, of body weight.

2. Methods

We conducted a *quasi-experimental*, study, comparing "before" and "after", in a non-probabilistic sample. Subjects' participation was voluntary, after advertising in the press media and via the internet. Inclusion criteria were: female gender, age from 30 to 50 years, without any menopausal signs and body mass index (BMI) above 30 kg/m^2. Exclusion criteria were: the use of drugs that modify metabolic rate and participation in any body weight loss programme during the last 6 months or during the study. Subjects also needed to be free from any pathologic thyroid alterations (checked by TSH analysis) and were non-smokers, at least during the previous six months. Written agreement was obtained from all individuals, and the study was approved by local Ethics Committee, protocol number 087/2006.

2.1. Procedures

Fifty women who satisfied the inclusion and exclusion criteria were selected and took part in a physical activity and nutritional education programme, as described below. Subjects were evaluated at the start and at the end of the programme, and only subjects who attended more than 75% of the total number of the physical activity and nutrition education sessions were included in the data analysis file.

2.2. Physical training programme

The women participated in a four-month physical exercise programme that included 30 min of aerobic and 30 min of resistance exercise three times a week. The combination of aerobic and resistance exercise was based on the recommendation of the ACSM.[8] During the first two weeks of familiarization, sessions were carried out together with a baseline one maximal repetition (1 MR) strength test, and the ergo-spirometric test. The exercise protocol consisted of walking on a treadmill at 65% VO_{2peak}, with heart rate monitored (Polar®). The resistance training consisted of three sets of 10 repetitions of different muscle groups, at 60–70% of the 1 MR. Once a week, the women undertook a sub-maximal 8 MR strength test to enable progressive adjustment of the weight lifted and a 12 min run test, to adjust the intensity of the aerobic exercise within a given heart rate zone.

Since physical training consisted of an aerobic and a resistance component, we considered the prediction of energy expenditure resulting from these exercises inappropriate. Excess post-exercise oxygen consumption (EPOC) can last for many hours after resistance exercise, thus, we concluded that energy expenditure prediction could be miscalculated. Since physical training was individualized with respect to VO_2 and 1 MR percentage, all the women were considered to be in negative energy balance and, therefore, were capable of reducing their body weight.

2.3. Nutritional education programme

The aim of the programme was to promote healthy behavior in relation to food choices, without recommending severe energy restriction or food exclusion or restriction. The subjects participated in weekly sessions in which topics such as the importance of nutrients and the definition of a healthy diet were presented and discussed. These meetings included lectures, discussions and practical activities in a dietetic laboratory. The total number of meetings, including practice and theory, was 13, and the subjects discussed were: -1. Introduction and identification of different food pattern; -2. Basic concepts of nutrition; -3. Sensory analysis, spices and herbs; -4. Food groups and the food guide; -5. Food servings; -6. Suggestions for healthy recipes; -7. Food behavior changes; -8. Food labeling, dietetic foods and light foods; -9. Low calorie deserts; -10. Chronic diseases and diet; -11. Functional foods; -12. Usual diets; -13. Final evaluation.

2.4. Initial and final assessment

2.4.1. Food consumption

To monitor the food consumption (FC), subjects filled in three daily food records, on non-consecutive days, at the start and at the end of the programme. They recorded all food and drink intake on the specified days, using domestic measurements. Women were instructed to record the information as soon as possible after eating or drinking. The records were analysed quantitatively for energy and macronutrients using Nutri-UNIFESP® software.

2.4.2. Anthropometry

Body mass (BM) (Filizola® scale with 0.1 g precision) and height (Secca® stadiometer to the nearest 0.1 cm) were evaluated to calculate BMI (body mass index, in Kg/m^2), and to classify subjects according to World Health Organization categories.[10] The waist (WC) and hip (HC) circumferences were measured, and the waist/hip ratio was calculated (WHR).[11] All the anthropometric procedures were based on Lohman, Roche & Martorell[12] and all measurements were performed by the same researcher at start and at the end of the programme.

2.4.3. Bioelectrical impedance analysis

Many studies of nutritional status use phase-sensitive single-frequency BIA measurement, which allows the impedance Z to be