



# A one-year resistance training program following weight loss has no significant impact on body composition and energy expenditure in postmenopausal women living with overweight and obesity

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## ABSTRACT

Resistance training (RT) has been shown to decrease fat mass (FM), and increase fat-free mass (FFM), which can be a useful for weight loss maintenance.

**Objective:** To examine the effects of a 1-year RT intervention on weight loss maintenance following a 6-month dietary weight loss intervention.

**Design:** Following a 6-month dietary weight loss intervention ( $-6\% \pm 5.8$ ;  $5.05 \text{ kg} \pm 4.45$ ), 70 postmenopausal women living with overweight or obesity were randomized to a control group ( $n = 34$ ) or a RT group ( $n = 36$ ) ( $3 \times /\text{week}$  first 6 months,  $2 \times /\text{week}$  last 6 months, 70–80% of 1-repetition maximum). Body composition (DXA), abdominal visceral adipose tissue (VAT) and subcutaneous adipose tissue (SAT) (CT scan), resting energy expenditure (EE) (indirect calorimetry), physical activity EE and total daily EE were measured (doubly-labelled water).

**Results:** A total of 54 participants completed the study (control group  $n = 29$ ; RT group  $n = 25$ ) and compliance to the RT program was on average 64%. Significant regains were noted for body weight  $0.98$  ( $3.71$ ) kg vs.  $1.33$  ( $3.94$ ) kg and FM regain  $1.32$  ( $2.69$ ) kg vs.  $0.81$  ( $3.26$ ) kg in control and RT groups after the 1-year weight maintenance phase. No group differences were noted. Resting EE and total daily EE did not change after the weight maintenance phase, and no differences were observed between groups. Both groups had significantly greater than predicted decrease in resting EE after the 6-month dietary intervention and at the end of the 1-year weight-loss maintenance phase.

**Conclusions:** Our results suggest that a 1-year RT intervention following a 6-month dietary weight loss intervention does not improve weight loss maintenance, body composition or EE in post-menopausal women living with overweight or obesity.

## 1. Introduction

Dieting is the most common approach employed for losing weight in individuals living with obesity [1]. Restricting intake leads to weight loss in the short term however, it induces relatively poor long-term success rate for weight reduction [2,3]. In fact, data from the

1999–2006 National Health and Nutrition Examination Survey have shown that only 18% of individuals who attempted to lose weight were able to maintain the weight loss over a period of 1-year [4].

The high rate of recidivism can be partially explained by the existence of central and peripheral adaptations that promote increased appetite and suppressed energy expenditure (EE), which collectively

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compromise weight loss maintenance [5]. Given the high correlation between fat-free mass (FFM) and resting EE [6], a decrease in body weight and FFM, are consequently accompanied by a decreased EE [7,8]. A common observation after weight loss is that measured resting EE is also often lower than expected [9,10]. More specifically, a portion of the decrease in resting EE would seem to partly stem from adaptive changes in thermogenesis [11], which has been described as a decrease in resting EE beyond what can be predicted by loss of fat mass (FM) and FFM [12]. Sustained lower thermogenesis following weight loss can compromise weight maintenance and increase the likelihood of weight regain [5].

Despite previously discussed observations [7–9,12], some individuals are able to maintain their weight loss over extended periods of time [13,14]. Data from the National Weight Control Registry reported that increased levels of physical activity is one of the most common characteristics of successful weight losers [14–16]. In fact, exercising has been reviewed as a potentially useful strategy for weight loss maintenance since it is one of the components of EE that is under voluntary control [17] and it has been proposed to likely be easier to manipulate than caloric restriction for long-term maintenance of weight loss [18].

Along these lines, a 1-year endurance training program was shown to improve weight loss maintenance compared to the control condition in men, whereas the regain in FM was also significantly lower in the training group [19]. Similarly, the inclusion of a walking program following weight loss improved weight loss maintenance in both men and women [20,21]. However, little attention has been given to the role of resistance training (RT) on post-weight loss weight maintenance and on the weight loss induced changes in EE, particularly in postmenopausal women.

RT could prove useful for improving weight loss maintenance since it can contribute to increase FFM [22], resting EE and physical activity EE [22–24]; as well as to influence substrate partitioning [24–26]. The re-analysis of the results from the classical Minnesota study revealed that FFM may well be an important driver of appetite and energy intake after weight loss [12]. Indeed, a sustained hyperphagic response was noted during the refeeding phase after weight loss; which only ceased when participants had recovered 100% of their pre-weight loss FFM. However, at that point, FM exceeded baseline values by 74% [12]. From these observations, one could hypothesize that accelerated recovery of FFM following weight loss could be associated to a reduced hyperphagic drive, and possibly to better weight loss maintenance.

The purpose of the study was to determine the effects of a 1-year RT program on weight loss maintenance and measures of EE following a 6-month dietary weight loss intervention in postmenopausal women. We first hypothesized that RT would lead to better body weight loss and FM loss maintenance in postmenopausal women than a diet only intervention. Second, we also hypothesized that RT would be associated with higher resting EE when compared to a diet only intervention.

## 2. Methods

### 2.1. MONET project

The first phase of the MONET study (Montreal Ottawa New Emerging Team) included a randomized controlled design to investigate the impact of a 6-month dietary vs. dietary + RT on weight loss in postmenopausal women. The second phase involved the sub-randomization of women of the dietary arm only to a 12-month weight loss maintenance phase that either included dietary recommendations with and without a RT intervention (Fig. 1). Metabolic, inflammatory and hormonal profiles, as well as body composition, measures of EE, psychosocial profiles were studied. The 6-month dietary intervention phase and results have been described in details elsewhere [27]. This manuscript presents results of women from the dietary arm only who completed both the weight loss and the weight maintenance phases of

the study. Measures presented include body weight and composition as well as energy expenditure.

### 2.2. Subjects

This prospective study included 71 overweight and obese postmenopausal women, who first completed a 6-month caloric-induced weight loss intervention. The study design is presented in the Fig. 1. Seventy subjects who completed the weight loss phase were randomized into a control ( $n = 34$ ) or RT group ( $n = 36$ ). One woman refused randomization. The study was approved by the University of Montréal, Faculty of Medicine Ethics Committee. Data were collected from 2003 to 2008. The inclusion criteria were as follows: 1) body mass index  $\geq 27$  kg/m<sup>2</sup>, 2) cessation of menstruation for  $> 1$  year and a follicle-stimulating hormone level  $\geq 30$  U/l, 3) non-smokers, 4) low to moderate alcohol consumption ( $< 2$  drinks/day), 5) free of known inflammatory disease, 6) no use of hormone replacement therapy, and 7) physical activity levels ( $< 2$  h/week of structured exercise). Furthermore, upon physical examination or biological testing, no participants had history or evidence of: 1) diabetes (fasting glucose  $> 7.1$  mmol/l or 2-h plasma glucose of  $> 11.1$  mmol/l after a 75-g OGTT), 2) untreated thyroid or pituitary disease, 3) chronic liver or renal disease, 4) asthma requiring therapy with steroids, 5) cardiovascular disease, peripheral vascular disease or stroke, 6) dyslipidaemia or hypertension requiring immediate medical intervention (total cholesterol  $> 8$  mmol/l, systolic blood pressure  $> 160$  mmHg or diastolic blood pressure  $> 100$  mmHg), 7) history of alcohol or drug abuse, 8) abnormal blood laboratory values (haematocrit  $< 32$  or  $> 48\%$ ; creatinine  $> 130$   $\mu$ mol/l), 9) use of medications that could affect cardiovascular function and/or metabolism, 10) known history of inflammatory disease as well as cancer, and 11) orthopaedic limitations.

Pre-, post-weight loss intervention and post 1-year follow-up testing was preceded by a 1-month weight stabilization period. Body weight was measured over the course of 4 consecutive weeks in order to verify weight stability ( $\pm 2$  kg). Assessment of anthropometric, and EE variables were performed after this period and were completed over approximately a month.

### 2.3. Nutritional intervention

The nutritional intervention for both groups consisted of monthly meetings with a registered dietitian. The total daily caloric intake was recommended to each participant (control and RT) and it was calculated based on their individual daily EE requirements measured by indirect calorimetry and by doubly labelled water (DLW) obtained from the measurements performed after the weight loss phase. All participants were encouraged to maintain their caloric intake based on their daily energy needs, with a macronutrient composition corresponding to 55%, 30%, and 15% of energy intake from carbohydrates, fats, and proteins, respectively. However, no individual meal plans were provided.

### 2.4. RT intervention

The 1-year RT weight loss maintenance intervention was performed weekly on 3 non-consecutive days for the first 6 months and on 2 non-consecutive days for the last 6 months. There is evidence in the literature demonstrating that RT practiced twice a week should be sufficient to promote healthy improvements in post menopausal women [28,29]. Accordingly, we opted to decrease the training frequency from 3 to 2 times a week in order to increase exercise compliance in our sample. The intensity of the RT was set approximately at 70–80% of 1-repetition maximum (1RM). Each training session included a warm-up period which consisted of low intensity walking on a treadmill for 10 min. Each exercise session was individually monitored for proper technique

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