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Original/*Deporte y ejercicio*

# A short-term circuit resistance programme reduced epicardial fat in obese aged women

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**Abstract**

***Introduction:*** **this study was conducted to ascertain the effects of resistance circuit training on epicardial adipose tissue (EAT) in obese aged women. A secondary objective was to assess muscle damage induced by supervised resistance training to confirm the intervention program was effective and safe.**

***Methods:*** **in the present interventional study, a total of 48 obese aged women were recruited from the community. Twenty-four of them were randomly assigned to perform a 12-week resistance circuit training programme, 3-days per week. This training was circularly performed in 6 stations: arm curl, leg extension, seated row, leg curl, triceps extension and leg press. The Jamar handgrip electronic dynamometer was used to assess maximal handgrip strength of the dominant hand. Two experienced observers assessed EAT by transthoracic two-dimensional echocardiography. Lastly, serum samples were analysed using one-step sandwich assays for creatine kinase activity (CK) and myoglobin (MB) concentration.**

***Results:*** **as was hypothesized, resistance training significantly reduced EAT thickness (8.4 ± 1.0 *vs.* 7.3 ± 1.3 mm; p = 0.014; d = 0.76) in the experimental group. Resistance training induced no significant changes in markers of muscle damage such as CK (181.6 ± 36.9 *vs.* 194.2 ± 37.8 U/l; p = 0.31) and MB (62.4 ± 7.1 *vs.* 67.3 ± 7.7 ng/ml; p = 0.26). No significant changes in any of the tested outcomes were found in the control group.**

***Conclusion:*** **resistance training reduced EAT in aged obese women. A secondary finding was that the training program was effective and safe. While current results are promising, future studies are still required to consolidate this approach in clinical application.**

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Key words: *Aged. Resistance training. Visceral fat. Myoglobin. Creatin kinase.*

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**REDUCCIÓN DE MASA GRASA EPICÁRDICA MEDIANTE ENTRENAMIENTO DE FUERZA EN CIRCUITO EN ADULTOS MAYORES OBESOS**

**Resumen**

***Introducción:*** **en la actualidad se acepta la asociación entre masa grasa epicárdica y patología cardiovascular. Recientes estudios sugieren que el ejercicio aeróbico podría reducir la masa grasa epicárdica. La originalidad de este trabajo reside en determinar la utilidad para tal fin de un programa de entrenamiento de fuerza en mujeres adultas mayores obesas. Como segundo objetivo nos propusimos que el programa fuese seguro para las participantes.**

***Material y método:*** **participaron voluntariamente 48 mujeres (70-75 años) con obesidad procedentes de la comunidad. De ellas, 24 fueron asignadas aleatoriamente al grupo experimental para desarrollar un programa de entrenamiento de fuerza en circuito de seis estaciones durante doce semanas con tres sesiones/semana. La masa grasa epicárdica se determinó mediante ecografía transtorácica bidimensional por personal entrenado. También se evaluaron los niveles plasmáticos de creatina cinasa y mioglobina. Este protocolo fue aprobado por un comité de ética institucional.**

***Resultados:*** **el grosor de la masa grasa epicárdica se redujo significativamente tras completar el programa de intervención (8,4 ± 1,0 *vs.* 7,3 ± 1,3 mm; p = 0,014; d = 0,76). Además, las participantes no mostraron cambios en marcadores de daño muscular como creatin kinasa (181,6 ± 36,9 *vs.* 194,2 ± 37,8 U/l; p = 0,31) y mioglobina (62,4 ± 7,1 *vs.* 67,3 ± 7,7 ng/ml; p = 0,26).**

***Conclusión:*** **el entrenamiento de fuerza en circuito reduce la masa grasa epicárdica de forma segura en mujeres mayores obesas. Aunque estos resultados son prometedores, aún son necesarios futuros estudios para consolidar su aplicación en clínica.**

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Palabras clave: *Mayores. Entrenamiento de fuerza. Grasa visceral. Creatina cinasa. Mioglobina.*

## Abbreviations

BMI: Body mass index.
CAD: Coronary artery disease.
CK: Creatine kinase.
DXA: Dual-energy X-ray absorptiometry.
EAT: Epicardial adipose tissue.
MB: Myoglobin.
WC: Waist circumference.

## Introduction

One of the hallmarks of advanced aging is the loss of muscle mass that has been strongly associated with increased risk of falling and a loss of functional independency[1]. Fortunately, supervised training programmes may reduce fear the occurrence of falls by improving strength, gait, balance and mood[2]. In a more detailed way, recent studies have also emphasized that resistance training should be an integral component of a fitness program given that endurance training alone was not sufficient to prevent the loss in muscle strength with aging[3,4].

Decline in muscle strength as well as attenuated cardiac function with aging not only leads to overall physical function decline but also has a close relationship with cardiovascular disease occurrence[5]. Although there is unanimous agreement on the importance of resistance training to improve muscle strength in aged women[6], there is no information in the literature regarding its influence on epicardial adipose tissue (EAT). This finding would be of particular interest to explain, at least in part, the impact of resistance training on cardiovascular disease risk factors and outcomes in older adults[7]. In this respect, it is widely accepted asymptomatic patients with coronary artery disease (CAD) have significantly more EAT than patients without CAD[8]. Similarly, increased EAT thickness assessed by transthoracic echocardiography is associated with deficient results of psychometric tests assessing cognitive performance, and may consistently foresee impairment of cognition in the elderly[9]. However, the validity of these observations is limited by the fact that the proportion of elderly people who do strength (resistance) training is currently low[10]. More recently, Harada *et al*. has already described several perceived barriers to strength training among older adults[11]. For the reasons already mentioned, this study was conducted to ascertain the effects of resistance circuit training on EAT in obese aged women. A secondary objective was to assess muscle damage induced by supervised resistance training to confirm the intervention program was effective and safe.

## Material and methods

### *Study population*

In the present interventional study, a total of forty-eight obese aged women were recruited from the community (Table I). The statistical package *GRANMO v7*.12 (IMIM, BCN, Spain) was used for sample size calculation. Inclusion criteria were defined as follows: woman, aged > 65 years-old, obese, sedentary (<20 minutes of aerobic exercise, twice per week, in the last six months[12]. Obesity was defined according to the International *Obesity Task* Force (IOTF) standards (BMI > 30 kg/m$^2$). Furthermore, all of them had medical approval for physical activity participation. Exclusion criteria were defined as the coexistence of uncorrected thyroid diseases, due to their impact on the body composition of these patients, diabetes, ischemic heart disease, cardiac arrhythmia, congestive heart disease, rheumatoid arthritis and chronic obstructive pulmonary disease (COPD).

### *Intervention programme*

Twenty-four of them were randomly assigned to perform a 12-week resistance circuit training programme, 3 days per week (Table II).

**Table I**
*Anthropometric and biochemical characteristics of obese aged women enrolled in the intervention and control groups at baseline*

| | *Intervention* | *Control* | *P value* |
|---|---|---|---|
| Age years | 67.3± 2.1 | 68.1± 2.3 | >0.05 |
| BMI (kg/m$^2$) | 31.2± 1.0 | 31.6± 1.2 | >0.05 |
| WC (cm) | 101.8± 4.6 | 103.6± 4.9 | >0.05 |
| c-LDL (mg/dl) | 131.7± 12.1 | 133.1± 13.2 | >0.05 |
| c-HDL (mg/dl) | 47.7± 5.2 | 46.0± 6.1 | >0.05 |
| Triglycerides (mg/dl) | 166.2± 14.8 | 168.6± 17.9 | >0.05 |
| Glycaemia (mg/dl) | 113.8± 5.4 | 115.1± 4.2 | >0.05 |

Note: WC: Waist circumference. c-LDL: Low density lipoprotein cholesterol. c-HDL: High density lipoprotein cholesterol.

**Table II**
*Characteristics of the resistance circuit training, comprised of 6 stations, performed by participants in the intervention group*

| | *1º-2º-wk* | *3º-4º-wk* | *5º-6º-wk* | *7º-8º-wk* | *9º-10º-wk* | *11º-12º-wk* |
|---|---|---|---|---|---|---|
| Load | 40% | 45% | 50% | 55% | 60% | 65% |
| Series | 2 | 2 | 2 | 2 | 2 | 2 |
| Rep. | 10 | 10 | 8 | 8 | 6 | 6 |
| Rest | 90 | 90 | 90 | 90 | 90 | 90 |

Note: Load: Expressed as percentage of 8 repetition-maximum (8RM) test. Rep: number of repetitions. Rest: resting periods between stations expressed in seconds.

This training was circularly performed in 6 stations: arm curl, leg extension, seated row, leg curl, triceps extension and leg press. Each training session started and finished with a warming-up and cooling-down period of 5-10 minutes during which muscle stretching exercises were performed. Furthermore, training sessions were in small groups (6 participants) and were supervised by experienced physical therapists to ensure that participants used the correct technique and intensity (ratio 1 monitor/2 participants).

It should be pointed out that before starting training program, participants included in the intervention group underwent a pre-training session to be familiar with resistance exercises as well as to perform the 8-repetition-maximum (8RM) test per each exercise[13]. Control group included 16 age, sex and BMI matched adults with DS who did not take part in any training program.

### *Nutritional intake record*

To control the potential confounding effect of diet, parents were carefully instructed to avoid quantitative or qualitative differences. Furthermore, they were asked to complete a food consumption frequency questionnaire for three days (2 weekdays and 1 weekend day). No significant difference was found between the intervention and control groups when assessing energy intake (1792±201 vs 1703±196kcal; p=0.41).

### *Outcome measurements*

All outcomes at individual level were assessed firstly at baseline and secondly 72-h after the end of the intervention.

Two experienced observers assessed EAT by transthoracic two-dimensional echocardiography (Vivid 7 system; GE-Vingmed Ultrasound AS; Horten, Norway) according to standard techniques stated by the American Society of Echocardiography[14]. In a more detailed way, epicardial fat thickness was measured in end diastole on the free wall of the right ventricle from the parasternal long- and short-axis views, as previously described[15]. Intra-observer and inter-observer variability of EAT thickness quantification was analyzed using the interclass correlation coefficient. In addition, the following equation was used to calculate the Body Mass Index (BMI = weight (kg)/height (m)$^2$), that was expressed as kg/m$^2$. Height was determined with an accuracy of 0.1 cm by precision stadiometer. Body weight was assessed with an accuracy of 0.1 kg using an electronic balance. Waist circumference was measured as halfway between the costal edge and the crista using an anthropometric tape (Holtain Ltd). It sould be pointed out these parameters were assessed according to the International Society for the Advancement of Kineanthropometry (ISAK) guidelines by a long experienced investigator who was not involved in any other aspect of the trial.

The Jamar handgrip electronic dynamometer (Bolingbrook, Illinois, US) was used to assess maximal handgrip strength of the dominant hand, defined as the one preferred for daily activities. The standard testing position, approved by the American Society of Hand Therapists, was used[16]. Three maximal attempts, separated each one by 90-second resting periods, were given by each subject. The highest value was considered for further analysis. Verbal encouragement was afforded to ensure maximal efforts. Furthermore, all participants underwent a preliminary session to be familiar with the correct use the dynamometer.

Regarding markers of muscle damage, blood samples were collected from the antecubital vein after a 12-h fast and collected by evacuated tubes containing EDTA. The whole blood was centrifuged at 3000 rpm for 20 minutes in a clinical centrifuge. The plasma was separated and stored at -80º C until further analysis. Serum samples were analyzed using one-step sandwich assays for creatine kinase activity (CK) and myoglobin concentration (MB) (Beckman-Coulter Inc).

### *Ethics and statistics*

It should be pointed out that the current protocol complied with the Declaration of Helsinki (2008). Written informed consent was obtained from all participants. Further, the current protocol was approved by an Institutional Ethics Committee. The results were expressed as a mean (SD). The Shapiro-Wilk test was used to assess whether data were normally distributed. To compare the mean values, a one-way analysis of variance (ANOVA) with post-hoc Bonferroni correction to account for multiple tests were used. For all tests, statistical significance was set at an alpha level of 0.05. Finally, Cohen's d statistics were used for determining mean effect sizes as follows: small $d > 0.2$ and $< 0.5$; medium $d > 0.5$ and $< 0.8$; large $d > 0.8$.

## Results

As was hypothesized, resistance training significantly reduced EAT thickness (8.4±1.0 vs. 7.3±1.3mm; $p=0.014$; $d=0.76$) in the experimental group. It should be pointed out that intra-observer reproducibility for EAT thickness measurements was excellent with a correlation coefficient of 0.97, while the inter-observer data showed a coefficient of 0.97.

When compared to baseline results, maximal handgrip strength was significantly greater (22.5±6.0 vs. 24.1±5.8 Kg; $p=0.028$; $d=0.94$). Resistance training induced no significant changes in markers of muscle damage such as CK (181.6±36.9 vs. 194.2±37.8 U/l; $p=0.31$) and MB (62.4±7.1 vs. 67.3±7.7 ng/ml; $p=0.26$).

Lastly, neither sports-related injuries nor withdrawals from the program were reported during the entire study period. Finally, no significant changes in any of the tested outcomes were found in the control group.

## Discussion

Taking into consideration the contribution of visceral fat mass to obese-related disorders, it has been proposed as a therapeutic target[17]. To the best of our knowledge, the current study was the first to evaluate the influence of resistance training on epicardial fat mass in aged women. As was hypothesized, strength training significantly reduced EAT. In a previous study, Fornieles *et al*. concluded a 16-week home-based treadmill training reduced epicardial and abdominal fat in postmenopausal women with metabolic syndrome[18]. Similarly, Brinkley *et al*. also found that a mixed protocol based on caloric restriction and aerobic exercise reduced pericardial fat in postmenopausal women[19]. It should be emphasized that our training program was not combined with a highly controlled dietary intervention, so that it may be considered more feasible and practical for participants. Furthermore, the present protocol lasted just 12 weeks in contrast to the 6-month exercise intervention designed by Jonker *et al*. to reduce pericardial fat volume in patients with type 2 diabetes mellitus[20]. Lastly, a recent systematic review and meta-analysis showed that an exercise program without hypocaloric diet has the potential to reduce visceral adipose tissue[21]. Thus, it would be possible to take preventive measures and implement early treatment in order to avoid complications and reduce associated health care costs associated to visceral fat in general and EAT in particular. Consequently, in addition to fulfilling the criterion of originality, this study also reflects contemporary criteria insofar as it may contribute to the sustainability of the health system in the present times of budgetary constraints.

In recent years many techniques have emerged for identifying and monitoring visceral fat both in clinical and research settings. Conventional kineanthropometric parameters are still used to determine abdominal fat mass due to their low cost and wide availability in any clinical setting[22]. However, these parameters do not differentiate between visceral and subcutaneous fat mass[23]. Consequently, an increasing number of studies recommend the use of imaging techniques since these are more accurate and reproducible although also more costly and complex[24]. In this respect, transthoracic echocardiography is receiving increasing attention given that it involves no radiation compared to computed tomography and dual-energy X-ray absorptiometry (DXA). In addition, it is simpler, faster and more accessible in clinical practice than magnetic resonance[25,26].

It is generally accepted that physical activity entails an inherent risk of musculoskeletal injury[27]. In this respect, the lack of qualified instruction that underlies poor exercise technique and inappropriate training loads could explain, at least partly, some of the reported injuries associated with resistance training[28]. Fortunately, our results suggested that a 12-week supervised resistance training did not increase markers of muscle damage in aged obese women. In addition, no sport-related injuries were reported in the experimental group. Similarly, the Cochrane review by Liu and Latham that included 121 trials with more than 6,700 older adults, concluded that adverse events typically were not reported[29]. Furthermore, the adherence rates in aged women enrolled in two different exercise programs (endurance training vs. resistance training) showed it was significantly higher in the strength training group[30]. Strengths of the current study included the homogeneous and large sample size. Conversely, previous studies focused on the influence of regular exercise on elderly have recruited mixed (male and female) groups in order to increase sample size with the aim of strengthening research design[31]. Furthermore, the presence of a control group consisting of age, sex and BMI matched women may reduce the recruitment bias of healthy controls. Lastly, the excellent adherence rate suggested the training program was effective and easy to follow-up. This was of particular interest given that it may finally give them the confidence to continue exercising after the trial finishes.

Finally, the present study had some limitations that should be considered too. We have not assessed markers of muscle stress immediately after the training session that would have provided more information regarding the release and clearance from the circulation of each biomarker. Furthermore, the use of weight lifting machines may limit the reproducibility of this study in case exercise equipment is not available. Accordingly, future studies focused on well-designed resistance exercise workouts that use free weight are also required to facilitate its reproducibility elsewhere.

It was concluded that resistance training reduced EAT in aged obese women. A secondary finding was that the training program was safe. While current results are promising, future studies are still required to consolidate this approach in clinical application given that EAT thickness has been associated with an unfavourable cardiometabolic risk profile even at early life stages[32].

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