

Efficacy and safety of spinning exercise in middle-aged and older adults with metabolic syndrome: randomized control trial

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Abstract

Background. Few studies have been conducted to investigate the effects of spinning exercise on cardio-vascular weal.

Aim. To assess whether a 6 months spinning training, combined with proper diet, is more effective than standard training programs and diet alone in improving metabolic abnormalities in middle-aged and older adults.

Design. Randomized clinical trial.

Setting. Rehabilitation Unit of our Department.

Population. Patients with Metabolic Syndrome (MetS) according to the National Cholesterol Education Program Adult Treatment Panel III diagnostic criteria.

Methods. Patients were randomly assigned to receive treatment with diet (group A, n = 10), with diet and general gymnastics program (group B, n = 10), with diet and spinning physical training program (group C, n = 10).

Results. During the study period we observed a significant reduction in blood pressure (group C: systolic blood pressure p = 0.03; diastolic blood pressure p = 0.004 / group B: systolic blood pressure p = 0.001), in lipid profile (group B: plasma total cholesterol p = 0.001; triglycerides p = 0.001 / group C: plasma total cholesterol p = 0.04); in fasting blood glucose (group B: p = 0.01; group C: p = 0.008); in Homeostatic Model Assessment of Insulin Resistance (group B: p = 0.01; group C: p = 0.001); in waist circumference (group C: p = 0.005; group A: p = 0.02; group B: p = 0.04). No patients reported adverse events during follow-up.

Conclusion. Our results confirm the effectiveness of spinning training combined with diet in the management of MetS.

Clinical rehabilitation impact. The findings provide a preliminary evidence to support that spinning training may represent a useful and safe intervention also in middle-aged and older adults geriatric with multiple CV risk factors.

Key words

- metabolic syndrome
- elderly
- spinning
- rehabilitation

INTRODUCTION

In the Western Countries the time devoted to physical activity linearly decreases with aging. The sedentary lifestyle strongly promotes and/or accelerates age-related conditions such as frailty and disability [1, 2] representing an independent risk factor for cardiovascular diseases (CVD) and all-causes related morbidity and mortality [3]. High level physical fitness could be helpful to prevent the development of chronic diseases [4].

Android obesity, hypertension, dyslipidemia and glycemic dysregulations are the known risk factors for CVD. The metabolic syndrome (MetS), a cluster of cardiovascular risk factors, reaches the highest prevalence in the elderly, reflecting the continuous worldwide growing of obesity. Several piece of evidence suggest that physical training should represent the primary therapeutic approach to prevent CVD, overall in the subjects with MetS [5-7], and it has been proved that

physical training can be effective in the elderly provided that suitable training programs are undertaken [8]. However, most studies that have demonstrated the relationship between physical fitness and MetS were performed with young or middle-aged adults [9-11] and relatively few studies have been conducted among elderly population [12, 13]. Furthermore, poor adherence to the exercise can make difficult the participation of elderly in rehabilitation programs. New strategies to improve motivation and compliance to physical training in elderly are needed [14-16].

The spinning is an aerobic activity on stationary bike, consisting of: the pedaling at different rhythms, mental concentration, emotional involvement and the use of specific music during training. The spinning sessions take place in groups; an instructor determines the pedaling rhythm according to the music. The mental involvement and concentration could improve physical adroitness and overcome physical fatigue. Few studies have been conducted to investigate the effects of spinning though some authors have demonstrated the beneficial effects of this pattern of physical activity on cardiovascular weal [17, 18]. Despite this, it has been emphasized that spinning puts strain on the cardiovascular system, questioning whether it can be recommended in the elderly [17]. Some authors suggested that spinning is unsuitable for sedentary individuals, especially if middle aged or elderly, who are willing to begin a recreational physical activity program [19]. However these studies have focused on young and accustomed to training subjects, who underwent intense exercise. These results should not be applied a priori to elderly subjects, for which lower intensity training programs should be definitely implemented.

The aim of this preliminary study is to assess whether a 6 months spinning training, combined with proper diet, is more effective than standard training programs and diet alone in improving metabolic abnormalities in elderly patients with MetS.

MATERIALS AND METHODS

Elderly patients who come to the Rehabilitation Unit of our Department were enrolled at this study. Eligible participants were middle-aged and older adults (50 to 69 years). Only those who had MetS were considered, according to the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) diagnostic criteria [20].

We excluded subjects who had resting systolic blood pressure (SBP) > 200 mmHg and/or diastolic blood pressure (DBP) > 110 mmHg; diabetic subjects with fasting blood glucose (FBG) > 250 mg/dl; unstable angina pectoris; arrhythmias; severe heart valves diseases; aneurysms; any kind of severe systemic diseases.

The study was conducted according to the guidelines on biomedical research involving human subjects (Declaration of Helsinki) and was approved by the "Science of Aging" Interdepartmental Research Center of Sapienza University of Rome. Informed consent was obtained from each patient.

In the same day of enrollment each patient underwent clinical interview, physical examination, anthropo-

metric assessment and venous blood sampling.

The clinical interview was aimed to investigate the current and past medical history, home therapy and general habits. The presence of comorbidities was assessed by the administration of the cumulative illness rating scale (CIRS) and calculation of the CIRS comorbidity index (CI) [21].

Waist circumference (WC) was measured at the level of iliac crest with the patients standing. The body mass index (BMI) was determined by dividing the weight (kilograms) by the square of height (meters). The ideal body weight was calculated for each subject using the following formula [22]: height (cm) – 100 – [height (cm) – 150/2 (for females) or 4 (for males)].

Standard laboratory techniques were used to determine, after an overnight fast, plasma total cholesterol (TC), high-density lipoprotein cholesterol (HDLc), triglycerides (TG), FBG and insulin.

The insulin-resistance was assessed through homeostatic model assessment of insulin resistance (HOMA) by the formula:

$$\text{HOMA} = [\text{plasma glucose (mg/dl)} \times 0.055 \times \text{Insulin (mmol/L)}] / 22.5.$$

Each subject underwent hemoglobin saturation monitoring through pulse-oximeter at rest and electrocardiography.

MetS was diagnosed (NCEP ATP-III criteria) by the presence of at least 3 of the following features: WC \geq 88 cm in females and \geq 102 cm in males; HDLc < 50 mg/dl in females and < 40 mg/dl in males; FBG > 100 mg/dl or anti-diabetic medications; fasting TG \geq 150 mg/dl or relevant drug treatment; SBP \geq 130 mmHg and/or DBP \geq 85 mmHg or anti-hypertensive medication.

We randomly divided the patients into three groups using computerized random numbers (Figure 1). The same pattern of diet was assigned for all, comprising of 24 kcal/kg (of ideal body weight).

Compliance to the diet has been monitored with daily food diaries. Diaries has been collected monthly.

The group A subjects were assigned to receive 6-month diet alone. Resting blood pressure, heart rate, pulsoximetry, FBG and WC were assessed monthly.

At the gym of our Department, the group B subjects were engaged, for the following 6 months, in two ses-

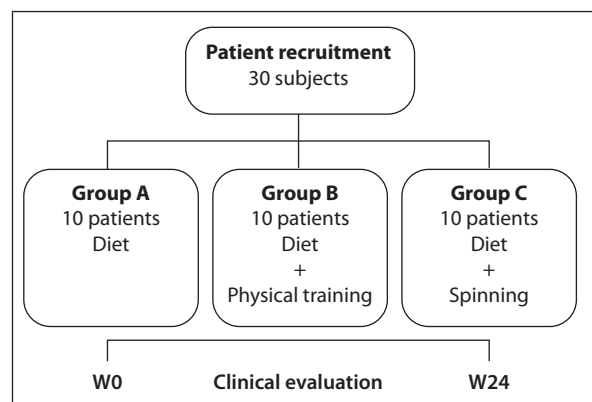


Figure 1
Study flow chart (W0 = Baseline; W24 = after 6 months).

sions of physical exercise a week, with each session lasting approximately 1 hour, under instruction of a therapist. All patients followed a group exercise program, characterized by walking and balance test, posture strengthening and treadmill exercises. Blood pressure, resting heart rate, pulseoximetry and FBG were assessed before and after exercise.

The group C subjects were assigned to receive a 6-month diet and spinning physical training program twice a week. The training was always preceded by muscle warming and followed by physical deconditioning. The training sessions were held in group listening to music. A 45 minutes playlist containing 13 tracks was used for mild-intensity sessions, while a 50 minutes playlist containing 15 tracks was used for moderate/high-intensity sessions.

Each spinning sitting consisted of:

- warm-up: mild intensity, slow pace: 60-80 pedal revolutions/minute (prm);
- seated climb: moderate/high intensity, moderate pace: 90-110 prm;
- sitting: moderate intensity, moderate pace: 80-100 prm;
- seated climb: moderate/high intensity, fast pace: 90-110 prm;
- cool down: mild intensity, slow pace: 60-80 prm.

Each patient could adjust the resistance of the bicycle through a handlebar placed device, according to their own feeling of fatigue. Blood pressure, resting heart rate, pulseoximetry and FBG were assessed before and after exercise.

In both group B and C: i) the physical activity was moderately intense so as not to exceed the target pulse rate, meaning 75% of the maximum pulse rate for the patient being treated (based on the theoretical maximum pulse rate by age, or on the Borg scale) [23]; ii) participants were asked to keep a self-monitoring diary identifying any adverse events about health and physical state. Diaries has been collected monthly.

To be included in the analysis, the participants had to

attend at least 80% of the training sessions.

We considered for the statistical analysis the data obtained at the baseline and those at the last follow-up (6 months). Data are presented as means \pm standard deviations. The baseline characteristics of the 3 treatment groups were compared by one-way analysis of variance (ANOVA), while the Student's paired T test was used to investigate within group differences comparing baseline variables' values with those at 6 months. A $p < 0.05$ was considered statistically significant.

RESULTS

Thirty patient were recruited at this study and all completed the 6 months protocol.

The group A (diet therapy) was composed of 10 subjects, males/females: 3/7, mean age: 62.5 ± 4.7 years, CI: 4; the group B (diet + physical training therapy) was composed of 10 subjects, males/females: 8/2, mean age: 60.7 ± 6.8 years, CI: 3; the group C (diet + spinning physical training therapy) was composed of 10 subjects, males/females: 6/4, mean age: 59.2 ± 9.1 years, CI: 4.

As shown in Table 1 at baseline we found a difference tending to the significance in SBP values between groups ($df = 2$; $F = 3.31$; $p = 0.052$). Post hoc were performed with Bonferroni correction and a tendency to significance was found between group A and C in SBP variables ($p = 0.06$). No differences were found in the other variables.

In all the three groups, we found that blood hypertension, obesity (stage I and II), diabetes/impaired fasting glucose, dyslipidemia and heart failure (NYHA class I, II and III) were the most prevalent diseases. The habits of the patients did not include diet and/or regular physical training. Some patients taking antihypertensive drug (group A and group B $n = 7$; group C $n = 8$; Ramipril 5 mg per day) and hypoglycaemic treatment (groups A, B and C $n = 3$; Metformin 500 mg three times a day). No significant differences between groups were found in the number of patients taking antihypertensive drugs ($df = 2$; $\chi^2 = 0.341$; $p = 0.84$) and hypoglycaemic drugs

Table 1
Baseline characteristics of the 3 treatment groups

| Variable | Group A Diet therapy N = 10 | | Group B Diet + Physical training N = 10 | | Group C Diet + Spinning training N = 10 | | F (df = 2) | P |
|----------|-----------------------------------|-------|---|-------|--|--------|---------------|------------|
| | M | SD | M | SD | M | SD | | |
| SBP | 130.00 | 13.33 | 140.00 | 10.54 | 144.00 | 13.49 | 3.31 | 0.052 (ns) |
| DBP | 82.50 | 4.25 | 84.00 | 6.99 | 88.00 | 7.53 | 1.96 | 0.16 (ns) |
| WC | 106.00 | 14.21 | 118.40 | 14.94 | 120.80 | 14.94 | 2.92 | 0.07 (ns) |
| TC | 223.91 | 28.58 | 240.00 | 30.52 | 246.31 | 68.05 | 0.627 | 0.54 (ns) |
| TG | 153.10 | 94.91 | 160.10 | 39.98 | 201.00 | 152.36 | 0.594 | 0.56 (ns) |
| HDLc | 53.10 | 9.43 | 53.10 | 12.27 | 52.70 | 12.62 | 0.004 | 0.99 (ns) |
| FBG | 108.40 | 18.78 | 112.40 | 8.65 | 113.40 | 9.92 | 0.399 | 0.67 (ns) |
| HOMA | 3.03 | 1.80 | 4.65 | 2.31 | 5.26 | 2.23 | 2.95 | 0.07 (ns) |

* $p < 0.05$

SBP: systolic blood pressure; DBP: diastolic blood pressure; WC: waist circumference; TC: plasma total cholesterol; TG: triglycerides; HDLc: high-density lipoprotein cholesterol; FBG: fasting blood glucose; HOMA: homeostatic model assessment of insulin resistance.

Table 2
Within group differences between baseline (T0) and 6 month follow up (T1)

| Variable | Group A Diet therapy N = 10 | | | | t (df = 9) | P |
|---|-----------------------------|--------|--------|-------|------------|--------|
| | T0 | | T1 | | | |
| | M | SD | M | SD | | |
| SBP | 130.00 | 13.33 | 130.00 | 13.33 | 0.000 | 1 |
| DBP | 82.50 | 4.24 | 82.50 | 4.24 | 0.000 | 1 |
| WC | 106.00 | 14.21 | 105.20 | 14.05 | 2.75 | 0.02* |
| TC | 223.91 | 28.58 | 220.40 | 31.43 | 1.13 | 0.28 |
| TG | 153.10 | 18.78 | 153.20 | 96.42 | -0.015 | 0.98 |
| HDLc | 53.10 | 9.43 | 50.90 | 11.27 | 1.83 | 0.11 |
| FBG | 108.40 | 18.78 | 103.20 | 10.83 | 0.862 | 0.41 |
| HOMA | 3.03 | 1.80 | 2.86 | 1.98 | 0.342 | 0.74 |
| Group B Diet + Physical training N = 10 | | | | | | |
| SBP | 140.00 | 10.54 | 133.00 | 9.48 | 4.58 | 0.001* |
| DBP | 84.00 | 6.99 | 80.00 | 6.67 | 1.50 | 0.17 |
| WC | 118.40 | 11.19 | 112.20 | 8.45 | 2.44 | 0.04* |
| TC | 240.00 | 30.52 | 210.60 | 22.53 | 5.18 | 0.001* |
| TG | 160.10 | 8.65 | 130.70 | 34.29 | 7.52 | 0.001* |
| HDLc | 53.10 | 12.27 | 49.90 | 10.47 | 1.02 | 0.25 |
| FBG | 112.40 | 8.65 | 104.40 | 8.39 | 3.22 | 0.01* |
| HOMA | 4.65 | 2.31 | 3.22 | 2.15 | 3.23 | 0.01* |
| Group C Diet + Spinning training N = 10 | | | | | | |
| SBP | 144.00 | 13.49 | 127 | 18.89 | 2.57 | 0.03* |
| DBP | 88.00 | 7.53 | 81.5 | 10.55 | 3.76 | 0.004* |
| WC | 120.80 | 14.94 | 112.30 | 11.5 | 3.69 | 0.005* |
| TC | 246.31 | 68.5 | 212.50 | 34.75 | 2.40 | 0.04* |
| TG | 201.00 | 152.36 | 172.80 | 86.67 | 1.09 | 0.28 |
| HDLc | 52.70 | 12.62 | 52.90 | 11.70 | -0.061 | 0.95 |
| FBG | 113.40 | 9.92 | 104.40 | 10.29 | 3.41 | 0.008* |
| HOMA | 5.26 | 2.22 | 3.19 | 2.05 | 4.50 | 0.001* |

*p < 0.05

SBP: systolic blood pressure; DBP: diastolic blood pressure; WC: waist circumference; TC: plasma total cholesterol; TG: triglycerides; HDLc: high-density lipoprotein cholesterol; FBG: fasting blood glucose; HOMA: homeostatic model assessment of insulin resistance.

(df = 2; $\chi^2 = 0.000$; p = 1). Not adjustment to pharmacological therapy were made during follow up.

No patients reported adverse events during follow-up. We also recorded a high adherence to diet in all three groups. The Table 2 shows the results at 6 months.

At 6-month follow-up we found that blood pressure significantly improved in groups B and C: in group C both SBP and DBP were significantly reduced (df = 9; t = 2.57; p = 0.03 and df = 9; t = 3.76; p = 0.004 respectively), against only SBP values in group B (df = 9; t = 4.58; p = 0.001). Any difference in blood pressure was observed in group A.

In group B we found a significant improvement in lipid profile: we observed a strong reduction in TC (df = 9; t = 5.18; p = 0.001) and TG values (df = 9; t = 7.57; p = 0.001), whilst in group C we found that TC was mildly lowered (df = 9; t = 2.40; p = 0.04) but not TG. No differences were found in group A. HDLc values

did not significantly increase in any group.

The FBG levels were significantly reduced in group B (df = 9; t = 3.22; p = 0.01) and C (df = 9; t = 3.41; p = 0.008); moreover HOMA improved in group B (df = 9; t = 3.23; p = 0.01) and in group C (df = 9; t = 4.50; p = 0.001). No differences were found in group A.

In all three groups we observed an initial reduction in BMI, especially in group C, where BMI was reduced by 9% compared to baseline values. Moreover we found a significant reduction in WC in all treatment groups, this reduction was greater in group C (df = 9; t = 3.69; p = 0.005) than in group A (df = 9; t = 2.75; p = 0.02) and B (df = 9; t = 2.44; p = 0.04).

DISCUSSION

Several piece of evidence suggest that physical training should represent the first-line therapeutic approach in the patients with MetS in order to reduce cardiovas-

cular morbidity and mortality [24-27].

Physical activity exerts several systemic beneficial effects, improving the muscle strengthening and the body coordination, the ventilator and maximum-aerobic capacities and the vascular compliance: so it represents a useful tool to reduce the risk of falls and fractures, to optimize the cardio-respiratory performances and to ameliorate the coronary perfusion.

Our study was aimed to test the spinning in middle-aged and older adults with multiple CV risk factors in order to suggest an alternative useful physical training.

We found that both standard physical training and spinning, added to diet, significantly improved lipid and glycemic profiles. The subjects receiving only diet probably require more time to achieve the same results.

According to previous reports [28], we found that standard physical training plus diet significantly lowers plasma TC and TG ($p = 0.001$). In those who performed spinning, we found a significant reduction of WC, BMI and blood pressure and an improvement of glucose homeostasis. As suggested by previous investigations [29], our findings indicate that spinning is widely effective in reducing body weight in a relatively short time, with positive psychological facing too.

However we observed the greater effects of Spinning on glucose metabolism. We founded a marked reduction in FBG, but also an improvement of insulin sensitivity as evidenced by the reduction of HOMA. Probably this could be largely ascribed to the greater weight loss obtained with spinning.

Therefore we demonstrated that spinning based training is more effective than standard aerobic exercise

in reducing body weight, FBG and insulin resistance.

Although some authors suggest that spinning may be too much intense in the elderly, we believe that it may be safe and useful if it is performed with caution.

In our experience, for example, we divided the spinning sessions into 5 sub-sessions, each composed of a different intensity workload. Moreover the subjects were free to modify the bicycle strength. The careful monitoring of heart rate, blood pressure, pulse-oximeter and glycemia, guaranteed to work safely.

CONCLUSIONS

Our results confirm the effectiveness of physical training combined with diet in the management of MetS. In this case, the spinning may represent a useful and safe intervention in middle-aged and older adults with multiple CV risk factors. The working group and the presence of an instructor may lead to increase the adherence to physical exercise.

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Conflict of interest statement

There are no potential conflicts of interest or any financial or personal relationships with other people or organizations that could inappropriately bias conduct and findings of this study.

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