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Original article

Effect of aquatic interval training with Mediterranean diet counseling in obese patients: Results of a preliminary study

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ABSTRACT

Background: No previous studies have investigated a high-intensity interval training program (HIIT) with an immersed ergocycle and Mediterranean diet counseling (Med) in obese patients. We aimed to compare the effects of an intensive lifestyle intervention, Med and HIIT with a water-immersed versus dryland ergocycle, on cardiometabolic and exercise parameters in obese patients.
Methods: We retrospectively identified 95 obese patients at their entry into a 9-month Med and HIIT program: 21 were trained on a water-immersed ergocycle and 74 on a standard dryland ergocycle. Body composition, cardiometabolic and exercise parameters were measured before and after the program.
Results: For obese patients performing water- and dryland-exercise (mean age 58 ± 9 years versus 55 ± 7 years), BMI was higher for the water- than dryland-exercise group (39.4 ± 8.3 kg/m^2 versus 34.7 ± 5.1 kg/m^2, $P < 0.05$), and total fat mass, fasting glycemia and triglycerides level were higher ($P < 0.05$). Both groups showed similarly improved body composition variables (body mass, waist circumference, fat mass, $P < 0.001$), fasting glycemia and triglycerides level ($P < 0.05$). Initial maximal aerobic capacity (metabolic equivalents [METs]) and maximal heart rate (HR_{max}) were lower for the water- than dryland-exercise group ($P < 0.05$). For both groups, METs, resting HR, resting blood pressure, abdominal and leg muscle endurance were similarly improved ($P < 0.05$).
Conclusions: A long-term Mediterranean diet and HIIT program with water-cycling is as effective as a dryland program in improving body composition, fasting glucose, triglycerides level, blood pressure and fitness in obese patients. A Mediterranean diet combined with water-cycling HIIT may be efficient for severely obese patients at high risk of musculoskeletal conditions.

1. Introduction

Obesity is a major public health concern associated with high health care cost and important comorbidities such as cardiovascular diseases, type 2 diabetes, stroke, hypertension, certain types of cancer and osteoarthritis [1–3]. Among the most effective strategies to prevent and treat obesity, long-term lifestyle intervention based on nutrition and physical activity is recommended for body composition and cardiometabolic risk management in obese populations [4]. A Mediterranean diet has been shown to reduce the incidence of major cardiovascular events in patients with high cardiovascular risk [5] and to be very effective in the reduction and long-term maintenance of body mass in obese patients [6,7]. In addition, a Mediterranean diet combined with high-intensity interval training (HIIT) for 12 weeks had greater benefits for cardiometabolic variables than the diet alone in patients with metabolic syndrome [8]. Similarly, we demonstrated that a program of 9 months of Mediterranean diet counseling (Med) and HIIT was efficient in improving body composition, systolic blood pressure (BP), and VO_2 peak [9–11]; the benefits were similar by gender and obesity phenotype [9]; the HIIT was well tolerated and safe at the cardiovascular level in these patients [9–11].

In obese populations, traditional modes of aerobic exercise, such as walking and/or running are often associated with increased risk of musculoskeletal injuries due to accumulated stress on

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lower-joint extremities [4,12], which reduces adherence to exercise training. Because of these musculoskeletal problems, the American College of Sports Medicine (ACSM) has recommended non-weight-bearing exercise including aquatic aerobic exercise for this population to reduce stress on the lower extremities and spine [4,13–15]. To date, only 2 short-term studies (12–13 weeks) have compared the effectiveness of aquatic aerobic exercise and dryland-exercise training on aerobic fitness and body composition in obese people [13,14]. The studies demonstrated a similar improvement in body composition and aerobic fitness with continuous walking exercise modes. However, the effectiveness of the water training program on other cardiometabolic risk factors (BP, glycemia, blood lipid levels) were not documented, and only one study used a nutritional intervention [13,14].

We recently developed a method to calculate external power output (P_{ext}) on an immersed ergocycle (IE) from the pedalling cadence in healthy adults [16,17]. This calculation is one advantage of use of the IE as compared to walking in water, for which P_{ext} is difficult to determine [16,17]. As well, because water immersion affects VO_2 and heart rate (HR), the use of a certain percentage of P_{ext} for HIIT prescription may be more practical and accurate than HR percentage [16,17].

To our knowledge, no previous studies have used a HIIT program with an IE in obese subjects. The aim of this study was to compare the long-term effects of a program of 9 months of Med and HIIT (intensive lifestyle intervention) involving an IE versus a dryland ergocycle on body composition, cardiometabolic and exercise variables in obese patients.

2. Material and methods

2.1. Patients

This retrospective study was conducted at the Cardiovascular Prevention and Rehabilitation Center of the Montreal Heart Institute. The data from a 9-month intensive lifestyle modification program (Med and HIIT) were analyzed. This clinical program was on a voluntary basis and participants were paying for the program. As well, patients could choose to do the exercise training on dryland or in the water according to their preference. Inclusion criteria at baseline were age >18 years and obesity defined as fat mass percentage >25% for men and >35% for women [18]. We included patients receiving pharmacological therapy for their cardiovascular risk factors (i.e., hypertension, diabetes). Patients with a history of coronary heart disease (documented previous myocardial infarction, coronary revascularization, or documented myocardial ischemia on myocardial scintigraphy) were excluded. We included 95 obese patients; 74 (mean age: 55 ± 7 years, body mass index [BMI]: 34.7 ± 5.1 kg/m^2, waist circumference [WC]: 110 ± 12 cm) were trained by standard dryland cycling and 21 (mean age: 58 ± 9 years, BMI: 39.4 ± 8.3 kg/m^2, WC: 115 ± 18 cm) were trained in the water with an IE [16,17]; the dryland and IE training are described below. The research protocol was approved by the Montreal Heart Institute Ethics Committee.

2.2. Measurements

Before and after the program, all patients underwent a complete clinical evaluation including measurement of height, body mass, WC, regional body composition with bioimpedance analysis (Tanita, model 418C, Japan) to assess fat mass, trunk fat mass, fat-free mass and resting metabolic rate [19]. Classical cardiovascular risk factors considered were diabetes, hypertension, active smoking and dyslipidemia [9,10,20]. A maximal exercise treadmill test with an individualized ramp protocol and fasting blood test (glucose, lipid profile) were also performed [15]. During the individualized ramp protocol, speed and slope were progressively increased to achieve a linear load and an exercise duration of approximately 10 min [21]. Criteria for the maximal exercise test were rate of perceived exertion ≥18 and/or ≥85% of age-predicted maximal HR, or patient exhaustion, with cessation caused by fatigue and/or other clinical symptoms (dyspnea, abnormal BP responses) or electrocardiogram (ECG) abnormalities that required exercise cessation. During maximal exercise testing, ECG and BP were monitored continuously during exercise and 5-min recovery [15]. Maximal exercise tolerance was defined as the highest level of metabolic equivalents (METs) achieved during the exercise test. All patients were instructed to take their usual medications before exercise testing and during the program. Patients also performed abdominal and thigh muscle endurance tests (Shirado test and squat wall test) as we previously described [9,10]. Attendance at the exercise training program was obtained from medical charts and from an electronic system that automatically records each subject's entry into our center, as we previously described [9,10,20]. Weekly supervised exercise training sessions and physical activity performed in and/or outside of the center were recorded in a diary [9,10,20].

2.3. Intensive lifestyle intervention program

Supervised exercise training sessions (HIIT and resistance exercise) consisted of 2 to 3 supervised weekly 60-min sessions. Subjects were encouraged to perform 1 or 2 additional unsupervised, continuous, moderate-intensity sessions per week, such as walking and/or cycling (45-min duration, Borg scale level: 12–14) at or outside of the center [9–11].

2.3.1. High-intensity interval training

HIIT prescription was based on the results of the baseline maximal treadmill exercise test and estimated maximal aerobic power (MAP) on dryland and IE as described [9–11,16,17]. MAP was estimated from the maximal metabolic equivalents treadmill value as follows: treadmill metabolic equivalents value was converted to oxygen uptake expressed in milliliters per minute; treadmill VO_2 peak in milliliters per minute was then converted to cycling VO_2 peak value in milliliters per minute by subtracting 16%; and cycling VO_2 peak value was then converted to watts by using a sex-specific conversion chart [10]. For the dryland-exercise group, HIIT sessions were performed on an ergocycle (Precor®, model 846i, USA) under supervision of a kinesiologist and consisted of a 5-min warm-up at 50 watts (W), followed by 2 sets of 10 min each of repeated bouts of 15 to 30 s at 80% of MAP interspersed by a 15- to 30-s period of passive recovery and a 5-min cool-down at 50 W [9–11]. The targeted Borg rating of perceived exertion (RPE) was set at 15 during the exercise sessions [9–11]. The two 10-min periods were separated by a 4-min passive recovery. Total exercise time was 34 min for the HIIT session [10]. For the water-exercise group, HIIT sessions were performed on an IE [16,17] (Hydrorider®, Aquabike professional, Italy) under supervision of a kinesiologist. The same HIIT protocol as for the dryland-exercise was used with the same percentage of MAP [16,17] and a targeted RPE of 15. The P_{ext} expressed in watts (W) was calculated by multiplying the total net force (F) overcoming the resistance of the system movement (pedalling system and legs) by the velocity (m/s) of pedal displacement as described [16,17]. Finally, a certain level of pedalling cadency (rpm) on the IE was used to give the corresponding 80% of MAP level; this rpm level was adjusted during HIIT to reach the targeted RPE of 15 [16,17].